PHILOSOPHICAL TRANSACTIONS.

Giving Some

ACCOUNT

OF THE

Present Undertakings, Studies, and *Labours*

OF THE

INGENIOUS,

IN MANY

Considerable Parts of the WORLD.

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PHILOSOPHICAL TRANSACTIONS

Jos: Banks

TO

Sir *HANS SLOANE*, Bar^t.

PRESIDENT of the

College of *PHYSICIANS*,

And VICE-PRESIDENT of the

ROYAL SOCIETY,

This Thirty Second Volume of

Philoſophical Tranſactions

is Humbly Dedicated

BY

His Moſt Obliged, and

Moſt Humble Servant,

JAMES JURIN, *R. S. Secr.*

Jos: Banks

Numb. 370.

Beginning the Thirty Second Volume.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *January*, *February*, and *March*, 1722.

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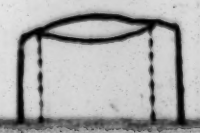
I. *The Longitude of* Buenos Aires, *determin'd from an Observation made there by* Pere Feuillèe. By Edm. Halley LL. D. *Astronomer Royal*, and F.R.S.

I HAVE as Occasion offered, made it my Business to collect such Celestial Observations as might be of Use to determine the Longitudes of Places on the Sea coast of the World; in order to get as near as possible the Out-line, or true Figure of the Earth, without which our Geography of the Inlands must necessarily be very insufficient. The Memoirs of the Royal Academy of *Paris*, afford a good Number of Observations of this Kind, and among the rest, there is one made at *Buenos Aires* on the River of *Plate*, in the South *America*, by *Pere Feuillèe* in his Voyage to *Peru*: who, in the Memoirs for the Year 1714. is said to have observed at that Place on the 19th of *August*, 1708. the Immersion of the Star in the Southern Foot of *Virgo* (marked by *Bayer* with λ) behind the obscure Limb of the Moon. Being desirous to see what Longitude might be deduced from this

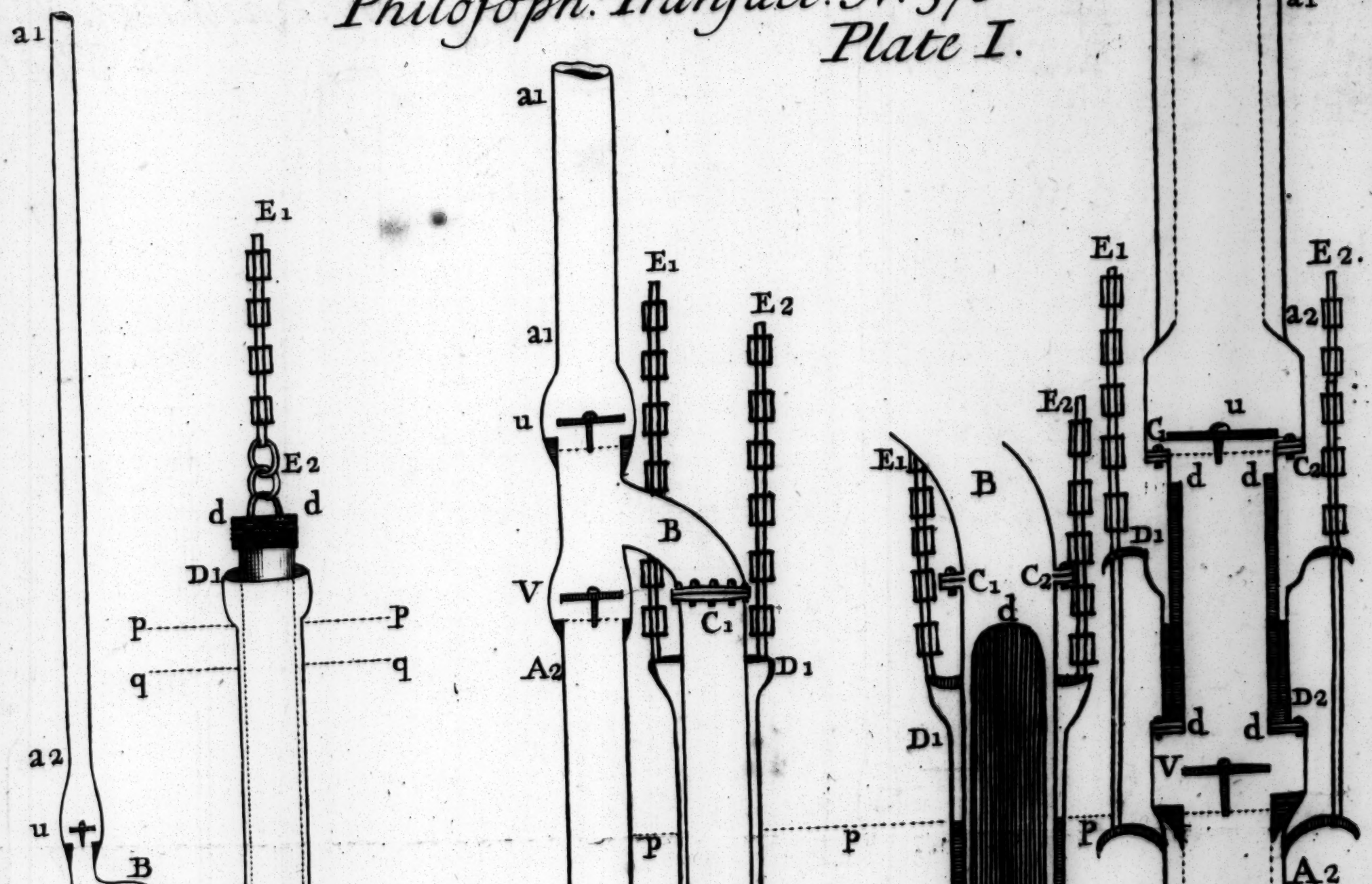
this Obſervation, I ſoon found that there was a Fault in the Day, and likewiſe in the Star; for that λ of *Virgo* was then nearly in 3 Degrees of *Scorpio*, and the Moon would not be there till the next Day, *Monday* the 20th of *Auguſt*; and the Latitude of λ being about half a Degree North, the Moon at that Longitude would be about 3 Degrees more Southerly than the Star, and conſequently far from Eclipſing it; for that at that time the deſcending Node was in the very Beginning of *Libra*. Hence I concluded it muſt be ſome other Star, that *Pere Feuillèe* obſerved Eclipſed by the Moon: The Day was certainly the 20th and not the 19th of *Auguſt*, as was evident by the Place of the Moon; but as to the Star, it was neither in the *Tychonick* Catalogue, nor yet in that more copious *Britiſh* Catalogue of Mr. *Flamſteed*; but turning over that of *Hevelius*, I found a Star whoſe Situation agreed well with the Obſervation, and was undoubtedly the Star that was ſeen to immerge behind the Moon: The Place Mr. *Hevelius* gives it, allowing the Preceſſion of the Equinox, was then ♏ 1° 56′¼ with South Latitude 2° 51′¼. It remained then for me to be aſſured of the Place of this Star, and accordingly on the 21ſt and 24th of *December* laſt, I got ſuch Obſervations by help of the circumjacent Stars, that I was aſſured the Place of the Star, (which is a fair Star, of the 5th Magnitude) was at that time, ♏ 1° 58′ 40″ with South Latitude 2° 54′½, being above 2′ in Longitude, and 3′ in Latitude, more than *Hevelius* gives it. The Hour of this Occultation is ſet down preciſely 7h 5′ 38″ at *Buenos Aires*, the Latitude of the Place being 34° 35′ South. Whence the Altitude of the Moon there was then 42° 48′, and the Parallactick Angle 76° 38′, and the Parallax in Longitude 40′ 11″ to the *Weſt* and in

Latitude 9′ 33″ to the *North*. So the Moon's obſerved Place corrected by Parallax was ♏ 2° 28′ 4″ with South Latitude 2° 52′½. To this Place, by the *Calculus* of thoſe Numbers I have fitted to our Preſident's Theory of the Moon (but which would be improper and too long to be here recited) the Moon will be found to have arrived *Auguſt* the $\frac{9}{20}$ at 10ʰ 57′ 36″ apparent Time at *London*. But at *Buenos Aires* it was then computed but 7ʰ 5′ 38″, whence the difference of Longitude reſulting from this Obſervation is 3ʰ 52′ or 58 Degrees, by how much *Buenos Aires* is more Weſterly than *London*. I have twice repeated the Calculation to be ſure to avoid error, and by comparing my Chart of the Variation with the Longitude thus found, it appears that in this Caſe a Ship at Sea uſing thoſe Tables and that Chart, would by an Obſervation of this Occultation have fallen with greater exactneſs on the Coaſt of *America*, than by any Reckoning can be pretended to be done.

II. *A*



Philosoph: Transact: N.° 370
Plate I.



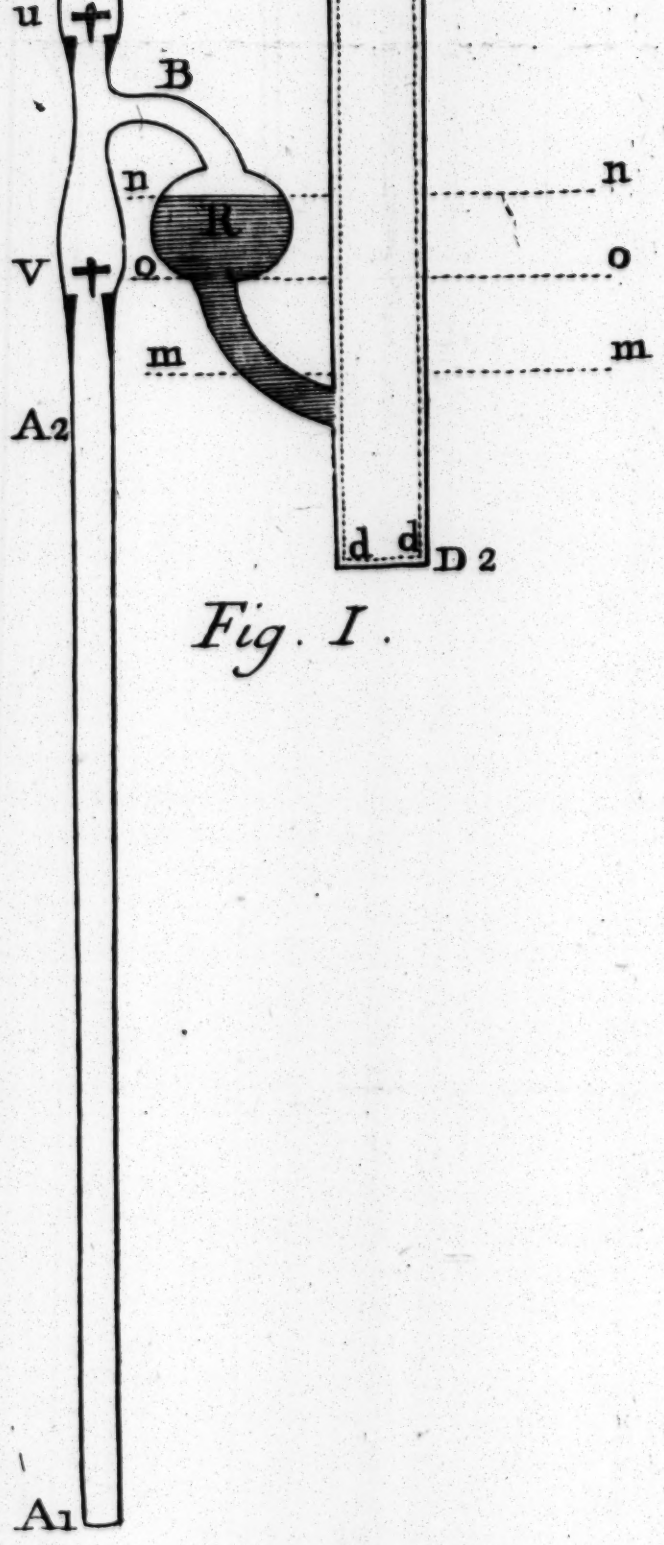


Fig. I.

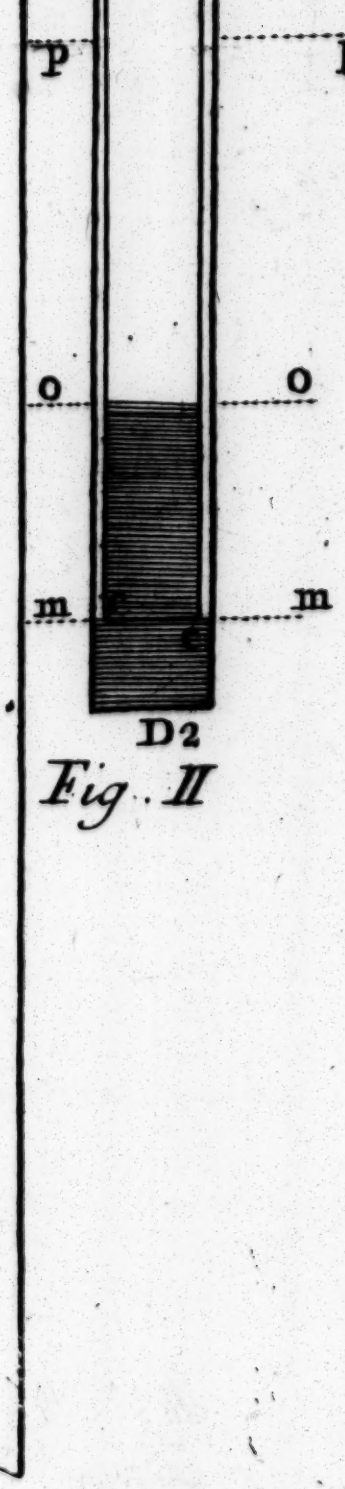


Fig. II



Fig. III

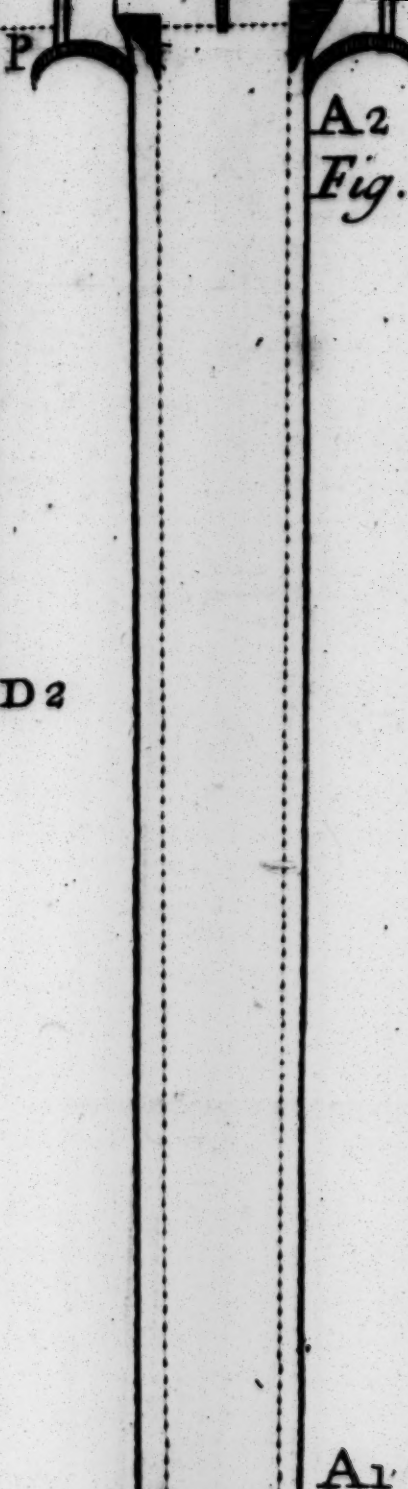


Fig. IV.

21

	Inner Cylinder. feet Inch.s tenths	2.d or Mid. Cylinder. f. i. t.	Out.r Cylinder f. i. t.
Length	2 . 7 . 2	2 5.0	2. 6
Diameter within	0 . 6 . 03	6.35	
Thickneſs	0 . 13	0.08	

Diſtance betwen Outer & Inner Cylinder 0.225

Depth of the Cup 5 Inches
Diameter 10.5
Length of Pendulum 9 foot
Stroke in y.e Cylinder 13 Inches

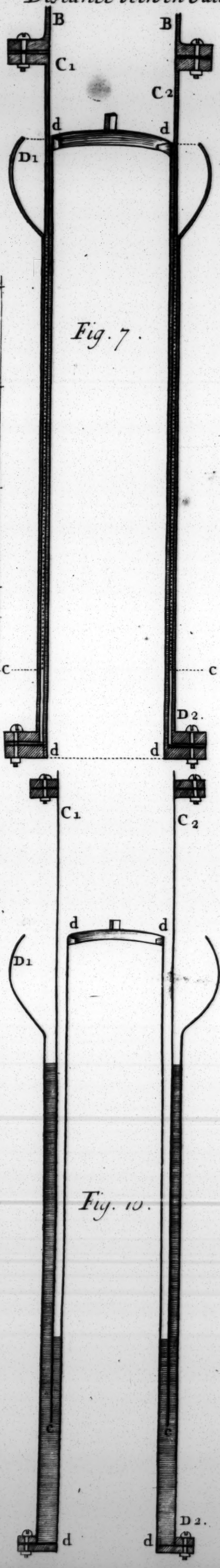


Fig. 7.

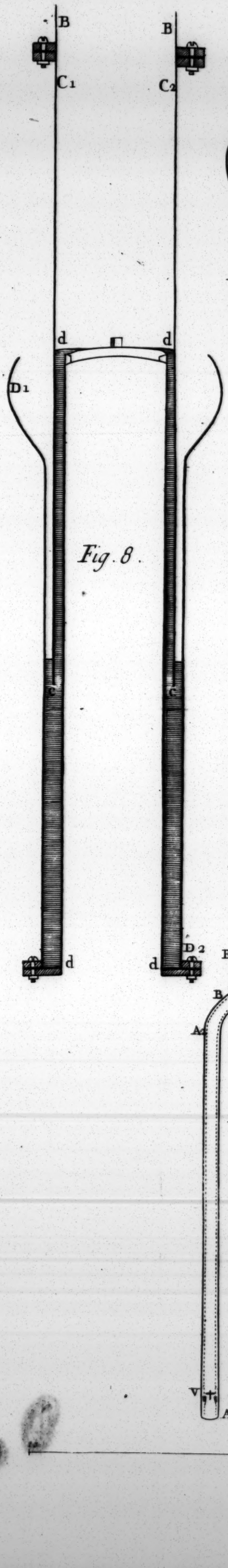


Fig. 8.

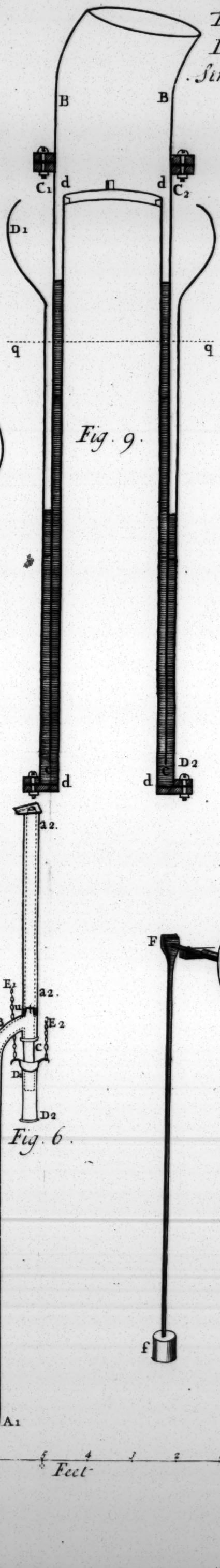


Fig. 6.

Fig. 9.

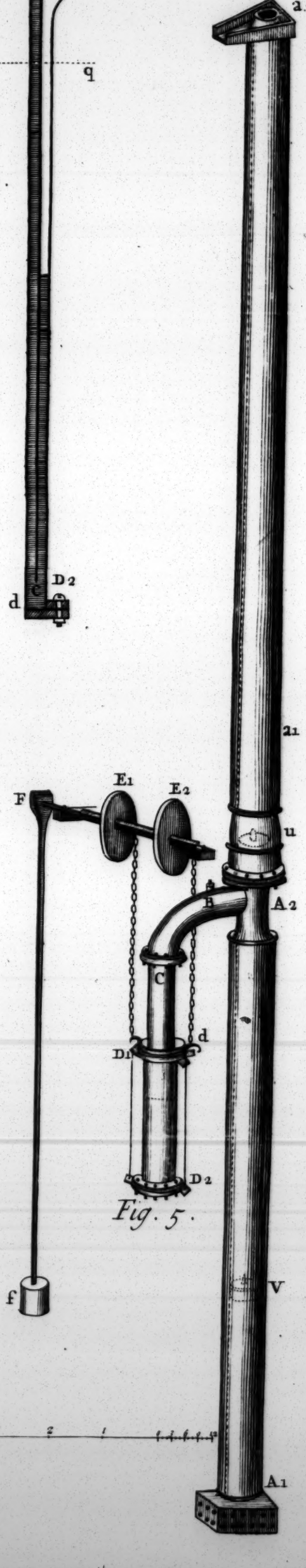
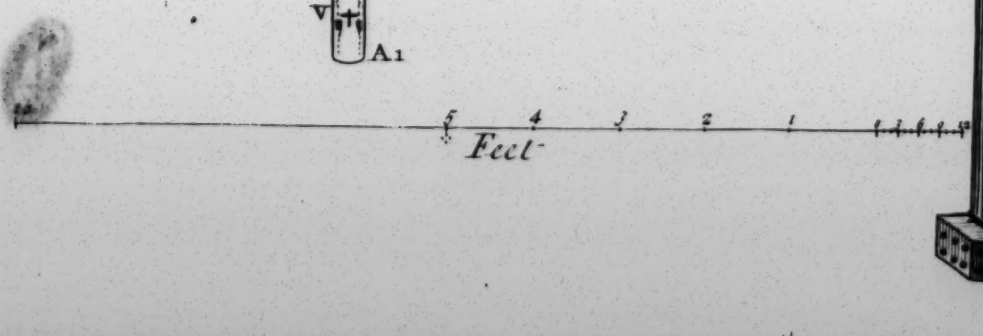


Fig. 5.

Fig. 10.



h of the Cup 5 Inches
meter 10.5
of foot
ches



II. *A Deſcription of an Engine to raiſe Water by the Help of Quickſilver, invented by the late Mr.* Joſhua Haskins, *and improv'd by* J. T. Deſaguliers, LL. D. R. S. S.

MR. *Haskins* finding that all Hydraulic Engines working with Pumps, loſe a great deal of Water, (always giving leſs than the Number of Strokes ought to give according to the Contents of the Barrels:) and that when the Piſtons are new leather'd to prevent that Loſs, the Friction is much increas'd, and the Engines are ſubject to Jerks, which in great Works do often diſorder an Engine for a great while, by breaking ſome of the Parts; contriv'd a new way of raiſing Water without any Friction of Solids; making uſe of Quickſilver inſtead of Leather, to keep the Air or Water from ſlipping by the ſides of the Piſtons in the Barrels where they work; hoping thereby to prevent all the aboveſaid Inconveniences, and alſo to have Water Engines leſs liable to be out of Order than any yet made.

The firſt Experiment he made with an Engine that he ſet up at my Houſe about two Years ago, which I repeated before the Royal Society in a Model; and tho', by the ill Contrivance of the Parts, it did not raiſe near the Quantity of Water that the Invention is capable of; yet I ſhall deſcribe the Machine here, becauſe it will ſerve for the better Underſtanding of our preſent Engine.

Fig. I.

dddd represents a *Lignum Vitæ* Plug or Piston (which Mr. *Haskins* call'd a Plunger) about 6 Foot long made heavy enough with Lead at top to sink into *Mercury*, which is beforehand pour'd into the Barrel D 1 D 2 up to *m m*. The Chain E 1 E 2, joyn'd to the Piston and the Power that moves it, being let down till the Piston comes to D 2, the *Mercury* rises to the same Height in the Barrel, and in the Receiver R, (which it fills) namely to *n n*, as appears in the Figure. Then drawing up the Piston till its Bottom is come to *m m*, the *Mercury* coming out of the Receiver down to *o o* makes a *Vacuum*, and the Weight of the Atmosphere causes the Water to rise up thro' the Sucking Pipe A 1 A 2, and Valve V into the Receiver where the *Mercury* was before. Upon letting down the Piston again, the *Mercury* rises into the Receiver, and drives up the Water thro' the Elbow B, the forcing Valve *u*, and so up the forcing Pipe *a* 2 *a* 1: But when once the forcing Pipe (which here was 46 Foot high) is full, before any *Mercury* can enter into the Receiver, and force any Water out at the top of the Pipe *a* 1, the *Mercury* between the Piston and Barrel must rise up to *q q* near 3 ½ Feet above the Bottom of the Receiver, and as it continues to rise up to *p p*, the Water is thrown out with a Velocity proportionable to the Height that the *Mercury* is rais'd above the 14th part of the Height of the Water. Now tho' the Friction of Solids is here avoided, it is plain that the *Mercury* must move from *m m* to *q q* without raising any Water, and that it can only force in going from *q q* to *p p*, and only suck in falling from *o o* to *m m*: And unless the Piston is stopp'd a little

little while when at loweſt, the Water won't have time to run out: So likewiſe the Piſton muſt be ſtopp'd when at higheſt, that the Receiver may have time to fill.

Mr. *Haskins* likewiſe propoſed another Way, repreſented in *Fig.* 2; where the ſame Letters repreſent the ſame Parts, only here the Barrel is moveable by the two Chains E 1 E 2, and inſtead of a ſolid Piſton, the hollow Cylinder C 1 *cc* is fix'd, and the *Mercury* moving up and down in the lower Part of it, ſucks and forces the Water thro' the Elbow. The Figure repreſents the Engine ſucking, by means of the *Mercury* hanging from *o o* to *m m*. In order to force, before any Water can be driven out, the *Mercury* in the inner Cylinder muſt deſcend from *o o* to *m m*, and riſe up to *p p* between that Cylinder and the Barrel; ſo that here alſo a great deal of time is loſt; beſides the great Quantity of *Mercury* us'd, which is very expenſive; becauſe as much *Mercury* is mov'd every Stroke as the Water rais'd.

Theſe Difficulties very much puzzled Mr. *Haskins*, and quite diſcourag'd ſome other Perſons that had got the Secret of the Invention, and were ſetting up againſt him. But when I had conſider'd the Matter a little, tho' I had not time to contrive a Machine for it, I told him, That a little *Mercury* might be made to raiſe a great Quantity of Water, and there ſhould not be ſuch a loſs of time as in his Engines; but that I would have him find it out before I aſſiſted him farther. In a little time he found out the Contrivance repreſented in *Fig.* 4; and afterwards that of *Fig.* 3; which laſt was what I had thought of: And both theſe were alſo found out by the late Mr. *William Ureem*, who was an excellent Mechanick.

Fig. III.

Here the Barrel is mov'd as in *Fig.* 2, but the Plug *ddd* taking up a great deal of Space, there is Occaſion for no more *Mercury* than what will make a concave Cylinder or Shell up to *pp* between the Barrel D 1 D 2, and the hanging Cylinder C 1 C 2 *cc*, when the Stroke is made for forcing; and a concave Cylinder between the Plug and C 1 C 2 *cc*, when the Suction is made. I gave Mr. *Haskins* the Proportions for an Engine this way, of which he made a Draught, and ſhew'd it to the Right Honourable the Lord Chancellour about ſix Months ago. This I mention here, that no body may endeavour to get a Patent for this Invention, to the Prejudice of Mr. *Haskins*'s Aſſignees; who, ſince his Death, have deſir'd me to aſſiſt them in perfecting the Engine.

Fig. IV.

Here the Barrel with a third Cylinder *dddd* inſtead of the Plug of *Fig.* 3, is lifted up and down every Stroke, and the Water paſſes thro' *dddd*, the *Mercury* making a Shell ſometimes between the middle and inner Cylinder, as in the Suction; and ſometimes between the Barrel and the middle Cylinder, as in the forcing Stroke.

Mr. *Haskins* had contriv'd ſuch a Machine as is repreſented by this 4th Figure, and beſpoke the ſeveral Parts before he dy'd; and therefore when I was deſir'd by his Aſſignees to direct the ſetting up the Machine, I was oblig'd to make uſe of the Pieces already made, in order to ſave the Expence of a new Engine: And now the whole put together with ſome

Al-

Alterations, make the Engine repreſented by *Fig.* 5, as it is ſet up at my Houſe in *Weſtminſter*, and by the Force of one Man, raiſes a Hogſhead of Water in little more than a Minute and a half to the Height of 27 Feet. All the Fault of the Machine of *Fig.* 5 is, that the Pendulum Handle *Ff* is too long, and the Bottom of the middle Cylinder C ought to be juſt in the middle of the Height to which the Water is to be rais'd, ſuppoſing three Copper Cylinders to be as they are here: If likewiſe the Barrel D 1 D 2 work'd under the forcing Pipe, the Lift would be eaſier. Therefore I deſcribe the Machine with the ſmall Alteration repreſented in *Fig.* 6.

The ſucking and forcing Pipe and Valves are mark'd with the ſame Letters as in the other Figures; and the Chains E 1 E 2 muſt be ſuppos'd to hang from ſuch Pullies, and to be mov'd by ſuch a Pendulum as is in *Fig.* 5. The Barrel D 1 D 2 (call'd otherwiſe the outer Cylinder, and repreſented by the ſame Letters in *Fig.* 7,) has within it another Cylinder (call'd the inner Cylinder or Plug, as *dddd Fig.* 7,) between which two Cylinders a certain Quantity of *Mercury* is pour'd in, and the hanging Cylinder C coming down into the *Mercury*, a Stroke of 13 Inches may be made by the Motion of the Barrel, which, in going down ſucks by making a *Vacuum* in C, and in going up forces the Water out of the top of the forcing Pipe, performing the Office of a common Piſton; only that inſtead of Leather to make it tight to the Cylinder C, there is always a thin Shell of Quickſilver either between the middle Cylinder C and the inner one, *(dddd Fig.* 7.) as happens when the Suction is made, or between the middle and outer Cylinder, as happens in lifting up the Barrel to Force. In the Suction, the *Mercury* is higher in the

inner

inner Shell than in the outer Shell, by an Height equal to a little more than $\frac{1}{14}$ Part of the Height of the Barrel above the Water to be rais'd: And in forcing, it is higher in the outer Shell than in the inner by a little more than $\frac{1}{14}$ of the Height of the Pillar of Water to be forc'd. And therefore if the Water is not required to be rais'd above 64 Feet, the Barrel ſhould move ſo as to make the Middle of its Stroke at the Height of 30 Feet, or at the middle of the way from the Water to be rais'd, to the Delivery at top.

The 7th Figure drawn by a larger Scale, repreſents the three Cylinders, which are here made of Copper in their juſt Proportions: And for the ſake of thoſe that would conſider this matter fully, I have here given their Lengths, Diameters within and without, and Thickneſs.

	Outer Cylinder or Barrel, D1 D2.	Middle or hanging Cylinder, in which the Stroke is made C1 C2 *cc*.	Inner Cylinder or plug cloſed at top by a Cap, and moving up and down with the Barrel to which it is joyn'd at bottom. *dddd*.
	Inches	*Inches*	*Inches*
Length	30	29,0	31,2
Diameter within.	6,74	6,35	6,03
Thickneſs	0,10	0,08	0,13
Diameter without	6,94	6,51	6,29

Here B B repreſents part of the Elbow of *Fig.* 5. or of the forcing Pipe of *Fig.* 6. But as the Spaces between the Cylinders are ſo ſmall, as not to be viſible even in a large Draught made by a Scale; I have here given three more Draughts of the three Cy-

Cylinders, where the Height is agreeable to the Scale of the 7th Figure, but the Diameters of the middle and inner Cylinders are made leſs than they are in the Engine, to make the Space between (where the *Mercury* riſes and falls) viſible; and the Cylinders themſelves are repreſented by ſingle Lines.

The Quantity of *Mercury* us'd in this Engine is 36 ½ Pounds, which being pour'd in between the outer and inner Cylinder, riſes up to the Height of 16 Inches.

When the Barrel is pull'd up (as in *Fig.* 9,) ſo as to have the middle Cylinder within an Inch of the Bottom of the Barrel; the *Mercury* on both ſides the middle Cylinder will riſe up to the Height of 23,1 Inches, that is about two Inches below the Cup D1, to the Line *q q*.

When the Barrel is going down to fill the ſucking Pipe and middle Cylinder C, the *Mercury* in the inner Shell will be 25 Inches high, and only 13 in the outer Shell, *Fig.* 9, where the ſhaded part repreſents the ☿.

At the End of the ſucking Stroke the *Mercury* is up to the top of the inner Cylinder, and ſcarce an Inch in the outer Shell. *Fig.* 8.

In raiſing the Piſton from forcing to Sucking, the firſt 1 ¼ Inch drives the *Mercury* out of the inner Shell, and raiſes it in the outer Shell 13,28 Inches.

The Depth of an Inch of Water in the middle Cylinder above the inner one or Plug is equal to a Space in the outer Shell of 13,28 Inches, and ¼ of an Inch is equal to the ſame Height in the inner Shell.

Therefore when the *Mercury* is equally high in both Shells, a Motion of ¼ of an Inch of the Barrel will charge for Suction. That is, upon letting down the Barrel only ¼ of an Inch, the Preſſure of the Atmoſphere in the outer Shell will raiſe the *Mercury* in the inner one 13,28 Inches, at the ſame time

time, that it puſhes up the Water from the Well 13 Foot and a half high into the ſucking Pipe. And when all the Pipes are full, if the *Mercury* be equally high in both Shells, upon raiſing the Barrel one Inch, the *Mercury* will riſe 13,28 Inches in the outer Shell; which I call charging for forcing; becauſe in continuing to raiſe the Barrel, the forcing Valve immediately riſes, and the Water comes out at top during the reſt of the Stroke, which is 12 Inches, and delivers 1,6 Gallon of Water, Wine Meaſure.

Fig. 10. repreſents the forcing Stroke half way up; with the ☿ 17 Inches in the outer Shell 4 Inches in the inner, and the whole ſpace at bottom under the middle Cylinder 7 Inches.

From this it appears, that in the whole Stroke of 13 Inches in Length, there is only $\frac{1}{4}$ of an Inch loſt to charge for Suction, and in the next ſtroke, which is likewiſe of 13 Inches, there is only one Inch loſt to charge for forcing; ſo that in a Motion of 26 Inches, there is but 1 $\frac{1}{4}$ Inch, or about $\frac{1}{20}$ part ineffectual. But this is owing to the too large ſpace of the outer ſhell, which contains 4 times more than the inner one, becauſe the Cylinders were only hammer'd, and not turn'd; for if the outer ſpace had been no bigger than the inner, then $\frac{1}{4}$ of an Inch of the ſtroke would have charg'd for forcing; ſo that only $\frac{1}{2}$ an Inch in 26, or $\frac{1}{52}$ part of the whole ſtroke would have been ineffectual; and in that Caſe, $\frac{2}{5}$ of the Quantity of *Mercury*, or a little more than 12 Pounds, would have been ſufficient.

There may ſtill leſs *Mercury* be us'd, if the middle Cylinder be made of Plate Iron turn'd on the outſide, and bor'd within, the outer Cylinder bor'd, and the inner one turn'd; ſo that if the Work be well perform'd, eight or ten Pounds of *Mercury* will be

be ſufficient in this Engine, tho' the Bore of the middle Cylinder, or Diameter of the Pillar of Water which is rais'd, be of 6,35 Inches. If the Bore of the ſaid Cylinder was but 3 Inches, leſs than 3 Pounds of Mercury would ſuffice, and leſs than ſix if there were two Barrels, in order to keep a conſtant ſtream thro' a Pipe of almoſt the ſame Diameter. This will very much leſſen the Expence of Mercury, which would otherwiſe be an Objection againſt this Engine; and by making the inner and outer Cylinder of hard Wood, as *Box*, or *Lignum Vitæ*, the Coſt of the Engine may ſtill be reduc'd. But if the Engine be very large, Caſt Iron bor'd will be proper for the outer Cylinder, and Caſt Iron turn'd on the outſide for the inner Cylinder or Plug, and hammer'd Iron bor'd and turn'd for the middle Cylinder.

There is an Objection, which ſeems at firſt to take off the intended Advantage of this Engine, which is this, *viz.* That inſtead of the Friction of the Leather of a Piſton, when we lift up our Barrel to force, the Reſiſtance, that the *Mercury* finds to riſe in the outer Shell, is at leaſt as great as the Friction that we avoid. Now that Reſiſtance is never greater than the Weight of a concave Cylinder of *Mercury*, whoſe Height is the greateſt to which the *Mercury* riſes in the ſaid Shell, and the Baſe is the Area of the Shell it ſelf. This Weight in our Engine is equal to 57,5 Pounds, and therefore one would think it greater than the Reſiſtance made by the Friction of a Piſton. But if it be conſider'd, that in the Deſcent of the Barrel for ſucking, the *Mercury* ſhifts immediately into the inner Shell, riſing to the ſame Height, and ſtill keeping the ſame Baſe; the aforeſaid Weight of 57,5 Pounds helps down the Barrel, and facilitates the overcoming of the Force of the Atmoſphere, conſequently the

Weight of the *Mercury* being balanc'd, is no Hindrance, whether you work with a ſingle or a double Barrel.

There remains only then the Hindrance by loſs of time in the Beginning of any Stroke: But I have ſhew'd that to be but $\frac{1}{5\frac{1}{2}}$ part of the ſtroke. I have found that the beſt Engines now in uſe generally loſe near $\frac{1}{5}$ of the Water that they ought to give, according to their Number of Strokes. And Mr. *Henry Beighton*, an ingenious Member of this Society, having a great many times meaſur'd the Water that is rais'd by Engines in Mines, found that ſome Engines loſt $\frac{1}{4}$, and none ever loſt leſs than $\frac{1}{5}$ of what they ought to give according to the Number of the Strokes in their Pumps, whatever auxiliary Powers they were mov'd with.

There is indeed another Objection, but ſcarce worth notice; which is, that ſome Particles of *Mercury* will mix with the Water that is rais'd, and make it unwholeſome; but no body that conſiders Specifick Gravity, will imagine any ſuch thing. However, to ſatisfie thoſe that might ſtill apprehend it, it is to be obſerv'd, that none of the Water that is rais'd comes near the Mercury: For in the Cylinder C, and part of the Elbow B, (*Fig.* 5.) there is always above the Mercury a certain Quantity of Water that riſes and falls with the Barrel, and never goes into the forcing Pipe. The ſame happens alſo in the Machine of *Fig.* 6. for the Water having once run into the Cylinder C. all that is rais'd afterwards, comes thro' the forcing Valve without coming down to the Mercury.

Provided Care be taken to make the Barrel with its Plug tight, I don't ſee that this Machine will want Repair in a long time, except ſome of the auxiliary Powers be out of order, which do not relate to this

this Invention. The Numbers given will ſerve to examine the Truth of what I have aſſerted concerning the Motion of the Mercury: And from them one may make Tables to ſerve to proportion theſe Engines for raiſing any Quantity of Water to any Height, according to the Power one has to apply.

III. *Part of a Letter from Mr.* Peter Derante, *Chirurgeon in* Waterford, *to Mr.* John Douglas, *Chirurgeon, F. R. S concerning the coming off of the* Scapula *and Head of the* Os Humeri, *upon a Mortification.*

ON the 5th of *November*, 1713, One *John Fletcher*, on board the *Neptune* of *Leverpool*, had the Misfortune to break the *Radius* and *Ulna* (of his left Arm) and their Ends burſt thro' the Skin. He was immediately dreſs'd by the Surgeon of the Ship with the common Aſtringents and Bandage; about five or ſix Days afterwards I was ſent for to go down to *Paſſage* to ſee this Man. When I came there, I found his Surgeon along with him, who told me, That the Man would do very well, becauſe he was in no pain at all; however, I deſir'd him to take off the Dreſſings, and let me look on't. Which being done, I found it was black and inſenſible from his Fingers to his Shoulder, and therefore adviſ'd the Extirpation of it immediately, but his Surgeon oppos'd it; however, I ſcarified it in ſeveral Places, and very deep, and then apply'd a warm Dreſſing. Next Day the Ship put to Sea, and the poor

Creature was ſent to *Waterford*, and committed to my Care. As ſoon as I could get my *Apparatus* ready, I cut off his Arm (in preſence of Dr. *Renet*, and Mr. *Carr* an Apothecary) as high as poſſible; then I cauterized the Stump, which was perfectly mortified as high as the *Acromion*. Next Day I perceiv'd the Mortification ſpreading toward the lower Angle of the *Scapula*, then I rubb'd the Edges of the Mortification with armed Probes dipt in a Solution of *Argentum Vivum* in *Aq. Fort.* which compleatly anſwer'd my Intention; for from that time the Mortification ſpread no further; next Dreſſing I ſcarified and cauterized all the mortified part, and dreſs'd it *S. A.* I continued this Method for ſeventeen or eighteen Days, and then the Sloughs began to ſeparate and caſt off daily; ſome time afterwards the *Scapula* began to part from the *Os Humeri* and *Clavicula*, and at length came out whole; I was then put to it what to do about the ſtump of the *Os Humeri*, which ſtill adhered to the *Pectoralis* and *Latiſſimus Dorſi*; but in a little time it alſo ſeparated and came away, without any Hemorrhage ſucceeding, which I expected. I was afterwards obliged to cut off part of the *Clavicula*, before I could cicatrize the Wound, which was ſoon afterwards accompliſhed. I have the *Scapula* and Head of the *Os Humeri* ſtill in my Cuſtody, and have ſhewn them to many Surgeons and Phyſicians. All *Waterford* is Witneſs of this Fact, and they called him ever afterwards *Three Quarters of a Man*.

I am, &c.

Waterford, Jan. 172$\frac{2}{2}$.

Pet. Derante.

IV. *Hydatidum ingenti copiâ in Abdomine repertorum Hiſtoria. Communicavit cum Societate Regiâ* Johannes Thorpe, *M. D. S. R. S.*

RHedarius Excell. S. D. Baronis de Penterrider, ætatis 58 annorum, Temperamenti ſic dicti Cholerico Phlegmatici, Staturæ quadratæ, non obeſus ſed robuſtus, bene appetens, officio ſuo bene fungens, nec vino, nec liquoribus ſpirituoſis immoderatè utens, bono ſatis Regimine vivens præterito Auguſti Menſe auxilium meum petiit, pro Abdomine fortiter tumente & tenſo, Aſcitico minimè abſimili, urinâ attamen bonæ notæ & in quantitate ſufficiente optimè prodeunte, pedum nullo œdemate comparente, Reſpiratione liberrimè procedente, ventre autem in dies creſcente (qui Menſe Junio tumere incepit) ſanguine in vaſis hæmorrhoidalibus ſtagnante, nodos ibidem magnos elevante & interdum dolorificè furente, Appetitu ac Viribus nunquam proſtratis.

Fateor Ænigma mihi fuiſſe an Tumor ſit ſiccus humiduſne? Ad ſatisfaciendum verò Indicationibus, in ſpecie hæmorrhoidibus ſuppreſſis, medicamenta chalybeata cum Purgantibus mixta exhibui, per quæ fluxus hæmorrhoidum mox excitatus, dolores ſedati, & magna ſordium quantitas cum aliquali levamine per tubulum inteſtinalem fuit eliminata. Poſtea ad exemplum Etmulleri in hydrope ſicco, Nitr. præparat. quotidie ad unc. ſſ. item Mercurium vitæ & omnis generis Diuretica mitiora, fortiora, &c. omnia incaſſum dedi.

Abhinc Patiens ſub ſanitatis recuperandæ ſpe, pro more Vulgi auxilium Empiricorum imploravit, qui ſta-

tim

tim Aureos ipſi montes promiſerunt, multisque ſaginatum Arcanis miſerum in malis deſeruerunt.

Abdomine igitur mole ſuâ maximè urgente, ad Paracenteſin ſine morâ progrediendum erat; quam die 14 Januar. Chirurgus Expertiſs. D. *Anel.* unanimi noſtro conſenſu Patienti adminiſtravit; contenta verò conſiſtentiam gelatinoſam nacta per anguſtius Cannulæ immiſſæ ſpatium exire non poterant. Inciſio ergo cum Lancetta facienda erat; quâ factâ, materia gelatinoſa coloris griſei & lutei, albumine ovorum ſpiſſior, cum magna quantitate globulorum alborum ſphæricorum, triangularium, vermicularium, gemellorum, teſticuli- & ovarii - formium, &c. magnitudinem nucis avellanæ adæquantium primo die ad menſuras ſex evacuata erat, ægro quantum ad vires optimè ſe habente. Poſtero die, cum facile judicare licebat, factam inciſionem non ſatis eſſe amplam pro exitu majoribus hujus naturæ globulis concedendo, Lancettâ igitur vulnus ampliabatur, per quod globuli ovum Columbinum magnitudine ſuperantes magno numero cum ſex iterum gelatinæ menſuris, & magno fruſto maſſæ cujuſdam albæ portionem omenti referentis, de novo excreti erant. Cui Maſſæ plures dictorum globulorum filamentis fibroſis adhæreſcebant.

In examinatione materiarum, gelatina ſuper carbonum ignem indureſcit & albeſcit, pelliculâ deſuper ſe formante.

Spiritu Vitrioli, Spir. Sal. Ammon. vol. Ol. Tart. per deliqu. Spir. Vin. rectif. Aceto affuſis, manifeſti nihil videtur, quàm levis induratio materiæ ab uno quoque iſtorum liquorum, etſi naturâ inter ſe invicem contrariorum.

Globuli coloris ſunt albiſſimi, ſenſui tactûs reſiſtentes; rupti liquorem album chylo ſimilem fundunt, membranâ ſeu pelliculâ manifeſtâ cincti.

Maſſa

Maſſa iſta albicans quæ portionem omenti refert, etſi craſſitie pollicem adæquet, ſubſtantiam purè membranaceam habet.

Numerus globulorum majorum & minorum ad ſeptem vel octo millia ſe extendit.

Hodie qui eſt incluſivè decimus ſextus ab operatione dies, æger quàm optimè ſe habet, venter eſt mollis, planus, vulnus pulcherrimum, urina, pulſus, reſpiratio bona, conſequenter nulla febris, ſomnus tranquillus. Evacuatio materiæ gelatinoſæ durantibus 13 diebus fuit copioſa, inodora, nunc purè ſeroſa & parca, ſed fortem odorem ſpirans, immiſſumque Catheterem argenteum nigricans, quod corporibus heterogeneis corruptis magis quàm vilceribus gangrænâ prehenſis attribuimus, quoniam febris abeſt. Hodie poſt injectionem Decocti ex Enula Campan. Agrimon. & Mell. cum Tinctur. Aloes. Myrrh. & Balſam. du Commandeur, rupti pellicula globuli fuit excreta, quem in ſtatu ſuo naturali ovum gallinaceum mole adæquâſſe, fortaſſis ſuperâſſe, certum eſt.

Appetitus & vires nunc ſunt quæ nobis faceſſunt. Medicamenta porrigo Traumatica, Alexiteria & Confortantia invicem combinata juxta victum Analepticum. Φαίνομενον notatu dignum examini verſatiorum in arte amicè diſcutiendum traditur, & ut animi ſui ſenſa nobiſcum communicare haud graventur, obnixè rogatur. Dabam Pariſiis d. IV. Calend. Januar. MDCC XXII.

Barthol. Anhorn, ab Hartuiſs.

V. *An Account of ſome Experiments made with the Bile of Perſons dead of the Plague at* Marſeilles, *with what appear'd upon the Diſſection of the Bodies; as likewiſe ſome Experiments made with the Bile of Perſons dead of other Diſeaſes. By the Learned and Curious Dr.* Deidier, *Profeſſor of Phyſick in the Faculty of* Montpellier. *Communicated by* John Woodward, M D. Prof. Med. Greſh. *and* R. S. S.

Experiments made upon the Bile of Perſons dead of the Plague.

Experiment I.

THE Human Bile, taken from the Gall-Bladder of the Bodies of thoſe that dy'd of the Plague at *Marſeilles*, has been always found to be of a black and greeniſh Colour. It has become conſtantly of a laſting Graſs Green upon the mixing of Spirit of Vitriol with it; and always very yellow when we mixt Oil of Tartar *per deliquium*, or the Alcalous fixt Salt of the ſame diſſolv'd in a ſufficient Quantity of Water. Theſe two Colours, green, and yellow, have continued for whole Months. The ſaid Bile has become of a black Colour, like Ink, but ſoon fading, by the Affuſion of Spirit of Nitr

Experiment II.

The Bile, taken from the Gall-Bladder of the Bodies of thoſe that dy'd of the Plague, having been pour'd

pour'd into a Wound made on purpoſe in different Dogs, has render'd them thereupon melancholy, drowzy, and without caring to eat. All theſe Animals dy'd in three or four Days with the eſſential Marks of the true Plague, declared by Buboes, Carbuncles, and gangrenous Inflammations in the *Viſcera*, in the ſame manner as in the human Carcaſſes from whence the Bile was taken.

Experiment III.

A Drachm of the ſaid peſtiferous Bile having been mix'd with two Ounces of Fountain Water made lukewarm, and injected into the Jugular Vein of ſeveral Dogs, has render'd them preſently drowzy, and has kill'd them in four Hours, with gangrenous Inflammations, the Heart ſtuffed full of black thick Blood, the Liver ſwell'd, and the Gall Bladder full of green Bile.

Experiment IV.

The ſame Quantity of Bile, injected by the Crural Vein, has produc'd in the Dogs a Heavineſs in about an Hour. They have had ſuch a ſtrong loathing of their Food, that they would not eat or drink the leaſt matter after the Injection was made. They piſs'd frequently, eſpecially if they were ſtirr'd. On the third Day there appear'd conſiderable Tumors under the *Axilla*, and on their Thighs, about 3 Inches from the Wound. The Wound turn'd to a Gangrene, and the Creature uſually dy'd on the fourth Day, with all the Marks of the Plague.

Experiment V.

A Dog, of the Hoſpital at the *Mail*, in *Marſeilles*, who follow'd the Surgeons when they went to dreſs the Sick, uſed greedily to ſwallow the corrupted Glands, and the Dreſſings charged with Pus that they took off the Plague-Sores; he lick'd up the Blood that he found ſpilt on the Ground in the Infirmary; and this he did for about three Months, and was always well, gay, brisk, full of Play, and familiar with all Comers. We injected into the right crural Vein of this Dog about a Drachm of the peſtiferous Bile, mix'd with two Ounces of warm Water. He dy'd the fourth Day, as the others did, with a Bubo on the wounded Thigh; on which likewiſe there were two Carbuncles, and the Wound gangren'd. What we took particular Notice of in this Dog was, that after the Injection, both when he was living, and after he was open'd, when dead, he had a very ſtinking Smell, which we did not obſerve in any of the others. He had moreover a conſiderable Hæmorrhage from the Wound, the Night before he dy'd, having ſtruggled hard to eſcape out of his Confinement.

Experiment VI.

The 2d of *May* having injected about a Drachm of humane Bile, taken from Perſons dead of the Plague, mix'd with two Ounces of warm Water, into the Crural Vein of a Dog, the Creature was preſently drowzy, refus'd his Food, and dyed about the third or fourth Day after the Injection, with all the inward and outward Marks of the Plague that the others had.

Expe-

Experiment VII.

The ſixth of the ſame Month we collected the Bile of this Dog dead of the Plague, and injected it by the Crural Vein into the Blood of another Dog, who, preſently after the Injection, had Convulſive Motions all over him, which were follow'd by a Lethargick Heavineſs. On the ſecond Day after the Injection, there appear'd a Carbuncle upon the great Pectoral Muſcle on the right ſide The third Day there aroſe a conſiderable Bubo on the Thigh; and the Dog dy'd the ſame Day. Upon opening the Body, we found the fore part of the Breaſt all gangren'd under the Teguments; and, in the inward parts, the *Viſcera* were full of black clotted Blood; as in all the reſt. The outward Surface of the Lungs was all Purple; The Heart was ſwelled as big again as uſual, with the four Cavities full of black clotted Blood. The Creature had liv'd three Days from the Injection without eating or drinking.

The 10th of *May* we injected the Bile of this ſecond Dog into the Crural Vein of a third Dog, who was thereupon ſeiz'd with violent Convulſions, and different convulſive Motions, for about half a quarter of an Hour. When he was recover'd from theſe, he appear'd dull, and ſleepy; he vomited with violent Strainings. The Vomiting was followed with a Hick-up. He eat a little boiled Meat, having faſted a good while before the Injection was made; but he vomited it up two Hours after he had taken it. He died the third Day with th e ſame Symptoms of the Plague that the other Dogs had.

The State of the Bodies of Perſons dead of the Plague, from which we took the Bile for the Experiments beforemention'd.

The firſt Body.

ONE *Belefleur*, a Soldier, of 25 Years of Age, of a ſtrong robuſt Conſtitution, having a flattiſh Bubo growing on the hollow of the right Groin, dy'd delirous. We found in his Carcaſs the Heart of an extraordinary Bigneſs, ſtuffed with black clotted Blood. His Lungs covered with a livid Purple, and ſticking a little to the *Pleura*. The Liver was double the natural Bigneſs, and ſtuffed with a thick Blood. The Gall Bladder was full of a black and greeniſh Bile. The *Dura* and *Pia Mater* by their Blackneſs ſeem'd to have been ſeized with a gangrenous Inflammation. The inward Subſtance of the Brain was ſprinkled over with an infinite number of ſmall livid Spots.

The ſecond Body.

Mary Piſanne, aged 30 Years, of a ſanguine Habit, had a *Bubo* under her right Arm-pit, with a *Delirium* that was followed by a mortal Sleepineſs. In the opening of her Body, we remark'd, that the Lungs were in their natural State. The Heart was of a prodigious bigneſs, full of black coagulated Blood, with the left Auricle livid and gangrenous. The Liver, which was much enlarged, was all cover'd with Purple;

ple; and the Gall Bladder fill'd with a black and greeniſh Bile. The Head was not open'd.

The third Body.

Peter Moulard, of a tender, feeble Conſtitution, about 14 Years of Age, had a *Bubo* under the hollow of the right Groin very deep, and that never came well out. He became delirous with Convulſions, in which this Child dy'd. We found in his Body his Heart of double the bigneſs that it ought naturally to be, containing a black thick Blood: His Lungs were beſprinkled with livid Spots. The Gall Bladder full of a black and greeniſh Bile. The Head was not open'd.

The fourth Body.

Jean Raynaud, Cook, aged about 25 Years, of a melancholy Temperament, had the whole Habit of his Body cover'd with a purple livid Colour, and a *Bubo* under his left *Axilla*; he dy'd in a delirous Phrenzy. We found in his Carcaſs two Abſceſſes, one between the Teguments and the left great pectoral Muſcle, and the other in the Breaſt between the *Sternum* and the *Mediaſtinum*. His Heart was very large, fill'd with black thick Blood. The right Auricle was of the Breadth of three Inches; the left was in its natural State. His Lungs were cover'd with little livid Spots, remaining ſoft and pliant, without any hardneſs in the Subſtance of them. The Liver was larger and harder than ordinary, and was alſo full of livid purple Spots; and the like were found in the Subſtance of his Brain, of which all the Veſſels were fill'd with black thick Blood.

The fifth Body.

Jaques Audibert, aged about 35, of a melancholy Complexion, four Months after he had been cured of the Plague, the Mark of which was a *Bubo* in the fold of the right Groin, which came well to a Suppuration, was attack'd afreſh with three Carbuncles; one in the middle of the Arm, and the other two in the fore Arm. He had but little Fever, with ſome ſmall Sickneſs at Stomach; but a *Delirium* coming of a ſudden, carried him off. Upon opening his Body, we found his Heart of a prodigious Bigneſs. The right Auricle being of the breadth of five Inches; and the left of three. We found a little Impoſtume upon the Body of the *Aorta*. The Lungs were cover'd with livid Spots, and the Liver appear'd gangrenous. The Gall Bladder was of a very black Colour. The *Duodenum* and the *Rectum* were inflam'd. We did not open the Head.

The ſixth Body.

Venture Cajole, about 40 Years of Age, of a melancholy Temperament, dy'd without any outward Eruption on the third Day, of a violent Fever, with a Sleepineſs. We found in the Body the *Mediaſtinum* torn towards the uppet part. The *Pericardium* was of a livid Colour. The Heart larger than in its natural State, by the ſwelling of its Ventricles full of black thick Blood, as in the other Carcaſſes. The Liver alſo was very large, and of a livid Colour, with a Carbuncular Puſtule on the ſide of the Gall Bladder; this was fill'd with very black Bile.

The ſeventh Body.

Margueritte Bachaire, aged 18 Years, of a lively vigorous Conſtitution, having two Carbuncular Puſtules on the middle and inſide of the Thigh, with a ſharp Pain in the Head, dy'd delirous. We found in her Body the Coverings of the Brain of a blackiſh red; The Cortical part of a livid Colour, and the Medullary ſprinkled with a few black Spots; The Heart of a prodigious Size, full of a thick black Blood: The Liver alſo very large, and the Gall Bladder very full of a black and green Bile. There were ſeveral livid Spots upon the Surface of the Inteſtines.

The eighth Body.

Louiſe Belingere, 20 Years of Age, having a *Bubo* in each fold of the Groin, died very ſuddenly without any dangerous Symptoms. We found in her Carcaſs the Heart all cover'd with a livid Purple, much larger than natural, fill'd with thick black Blood, having a *Polypus* in each Ventricle. The Lungs were in their natural State. The Liver of a prodigious Greatneſs; and the Gall Bladder full of Bile, of a deep green Colour.

The ninth Body.

One nam'd *Rampeau*, a Peaſant, aged about 20 Years, of a ſanguine robuſt Conſtitution, having had a Carbuncular Parotide for the Space of eight Days, accompany'd with a burning Fever, was carried to the Hoſpital the 2d of *May*, where he dy'd the 5th. We found the outward part of the left ſide of the Lungs cover'd with

with a livid Purple. The Heart was of double th natural Bigneſs, having ſcarce any Blood in the Ven tricles, whoſe Cavities were fill'd each with a large *Polypus*, that on the right ſide having dilated the Auricle to the breadth of four Inches. The Liver alſo was larger than ordinary, and the Gall Bladder was full of a black and green Bile.

The Experiments, and the opening of the Bodies mentioned above, were made in the Hoſpital at the *Mall*, and in the Apothecary's Shop of the Reverend the Reformed Fathers of *Marſeilles*, during the Months of *February*, *March*, *April*, *May*, in Company of Meſſ. *Roberts* and *Ribeaud*, Doctors of Phyſick.

The following Experiments were made at Montpelier, *in the Hoſpital of* St. Eloy, *during the Months of* September, October, *and* November, *in company with Monſ.* Fizes, *Dr. of Phyſick, and Profeſſor of the Mathematicks, and Meſſieurs* Duli *and* Morel, *young Surgeons of the ſaid Hoſpital.*

A Soldier, between the Age of 20 and 25, of a lively brisk Temper, being ſick in the Hoſpital of St. *Eloy* of an ordinary malignant Fever, died about the 15th Day by a Defluxion upon his Breaſt. His Lungs were found very much blown up, filling all the Cavity of the Breaſt, and adhering to the *Pleura*. Having remark'd that the Bile in the Gall-Bladder was of a bright Graſs green Colour, we gather'd it for the following Experiments.

This

This Bile, being mingled with four Ounces of warm Water, was part injected into the Jugular Vein of a Dog, and a Compreſs ſoak'd in the reſt of the Liquor was applied to the reſt of the Wound. The Creature thereupon appear'd heavy and ſleepy, and would neither eat nor drink; the third Day he eat and drank willingly. The Compreſs falling off the fourth Day, the Wound was diminiſhed one half, and was healed by little and little, and the Dog grew perfectly well.

The eighth Experiment.

A Peaſant of about 50 or 60 Years old, of a melancholy Temperament, had been near a Month in the Hoſpital with an ordinary malignant Fever, having alternatively a *Delirium* and a Sleepineſs. After his Death, the Bile was found extreme thick, and black as Ink, and a great deal of it. We put about a Drachm in a Wound made for that purpoſe on the outer part of the right Thigh of a Dog, thruſting in Pledgets dipt in the ſaid Bile diluted, into the Wound. There did not appear any Change in the Dog. We made him ſwallow ſome of the ſame Bile, without loſing his Appetite; and ſeeing he was like to do well, we left the Wound to it ſelf, which heal'd in fifteen Days only by the Dog's licking it.

The ninth Experiment.

Being willing to inject ſome of the ſame Bile into the Crural Vein of another Dog, and the Syringe being ſtopt by the too great Thickneſs of the ſaid Bile, the Injection could not be made; wherefore we took a Pledget ſoak'd in as much of this Bile diluted, as it

could take up, and apply'd it to a freſh Wound made in the inſide of the right Thigh. The Pledget was faſten'd within the Skin by ſome Needles. This Application produced no conſiderable Alteration in the Dog; he neither appear'd ſleepy nor ſtomachleſs; but lick'd his Sore readily enough; and after the Pledget was fallen off, the Wound heal'd as in the foregoing Experiment.

The tenth Experiment.

About a Drachm of the ſame black Bile drawn from the ſame Carcaſs, and mixed with warm Water, was injected into the Jugular Vein of another Dog. The Creature was not incommoded thereby, but was as brisk as before the Injection, only he appear'd very thirſty and he drank with Greedineſs. The next Morning being willing to view the Wound, we found it black and dry, and the Dog becoming ſurly, bit one of the Aſſiſtants. The two Ligatures made for the Injection were taken away without our ſeeing any Blood to run out. We apply'd a Doſſil, charged with the ordinary Digeſtive, and kept on by a Bandage; and about four Hours after the Dreſſing, we found the Dog dead, having lived 23 Hours after the Injection. Having opened him, we found that his Heart beat ſtill with Violence, and the beating ceaſing, there was no Blood either in the Ventricles or the Auricles. This Liquor crowded together in the great Veſſels, appear'd of a lively red, and very fluid, without any of thoſe Concretions that we conſtantly obſerved in all the Bodies that dy'd of the Plague. Here appeared neither internal nor external Marks of the Plague.

The eleventh Experiment.

An Inhabitant of *Montpellier*, aged about 30 or 35, very fat and robuſt, of a ſanguine Complexion, having had a Fall upon the Pavement, had received a ſimple Wound on the upper part of his Forehead on the right ſide. This being neglected, brought on an *Eryſipelas* all over his Face, which was accompany'd with a Swelling of the left *Parotide*. This appear'd and diſappear'd thrice from Morning till Night. The *Eryſipelas* came ſuddenly on; he grew delirous, and died after fifteen or twenty Days Illneſs, reckoning from the Fall. In the opening of the Body, we found a quantity of Water between the Skull and the *Dura Mater*. The Brain, which was firmer than ordinary, was a little red, and part of the *Pia Mater* covering the hinder part of that *Viſcus*, appeared inflam'd. There was about half a Septier of Water of a yellowiſh Colour, ſhed in the Cavity of the Breaſt. The great right Lobe of the Lungs was a little hard on the upper part. The Heart had a Polypoſe Concretion in each Ventricle: We found likewiſe two Pints of limpid Water got forth into the lower Belly. All the Fat of his Carcaſs was yellow. The Liver appeared to us a little ſwell'd; and the Gall Bladder almoſt empty, not having above two Drachms of yellow Bile in it. That Bile of this Carcaſs, mixed with two Ounces of warm Water, was injected into the Crural Vein of a Dog. The Creature eat and drank heartily after the Injection, and did not appear at all incommoded. The Wound bleeding much, we were obliged to fill it with reſtringent Powders, kept in by a Pledget and a convenient Bandage. Twenty four Hours after, the Dreſſing was taken away, the

Wound appeared black and dry. The Dog licking it, it ſuppurated the next Day, and afterwards became red and well colour'd; and the Wound was leſſen'd one half in eight Days, during which time, the Dog appeared in perfect Health.

The twelfth Experiment.

Eight Days after the foregoing Experiment, the Dog, that was the Subject of it, was kill'd by about half a Drachm of Powder of *Hungarian Vitriol*, diſſolved in a ſpoonful of warm Water, which we injected into the Jugular Vein. The Creature dy'd on the ſpot, with univerſal Convulſions. His Heart was found full of grumous Blood reduced to a kind of thick Pap, but without any Clods. The Bile of this Dog was yellow and in little quantity. Not being able to inject it into the Crural Vein of another Dog, becauſe the Vein was too ſmall, we contented our ſelves to dip two Compreſſes in this Bile, which we apply'd and kept under his Skin, by two Wounds made on purpoſe in this ſecond Dog: There arriv'd no notable Change. We obſerved in theſe two Dogs no Marks either internal, or external, of the Plague.

Done at Montpelier *the 4th of* December, 1721.

VI. *The way of proceeding in the* Small Pox inoculated *in* New England. *Communicated by* Henry Newman, *Esq*; *of the* Middle Temple.

1. WE make uſually a Couple of *Inciſions* in the *Arms* where we make our *Iſſues*, but ſomewhat larger than for them, ſome times in one *Arm*, and one *Leg*.

2. Into theſe we put bits of *Lint*, (the patient at the ſame time turning his Face another way, and guarding his Noſtrils) which have been dipt in ſome of the *Variolous Matter* taken in a Vial, from the Puſtules of one that has the *Small Pox* of the more laudable Sort, now turning upon him, and ſo we cover them with a Plaiſter of *Diachylon*.

3. Yet we find the *Variolous Matter* fetched from thoſe, that have the *inoculated Small Pox*, altogether as agreeable and effectual as any other. And ſo we do what is taken from them that have the *Confluent Sort*.

4. Within Four and Twenty Hours, we throw away the *Lint*, and the *Sores* are dreſſed once or twice every Four and Twenty Hours, with warmed *Cabbage Leaves*.

5. The Patient continues to do all Things, *as at other times*, only he expoſes not himſelf unto the Injuries of the *Weather*, if that be at all Tempeſtuous.

6. About the Seventh Day the Patient feels the uſual Symptoms of the *Small Pox* coming upon him; and he is now managed as in an ordinary *Putrid Fever*. If he cannot hold up, he goes to *Bed*; If his

Head

Head ach too much, we put the common *Poultice* to his *Feet*, if he be very Sick at the *Stomach*, we give him a *gentle Vomit*, yea, we commonly do theſe Things *almoſt of Courſe*, whether we find the Patient want them or no. And we reckon the *ſooner* we do theſe Things, the *better*. If the *Fever* be too high, in ſome Conſtitutions, we *Bleed* a little: And finally, to haſten the Eruption, we put on a Couple of *Bliſters*.

7. On or about the Third Day from the Decumbiture the *Eruption* begins. The Number of the *Puſtules* is not alike in all, in ſome they are a *very few*, in others they amount to an *Hundred*. yea, in many they amount unto *ſeveral Hundreds*; frequently unto more than what the Accounts from the *Levant* ſay is uſual there.

8. The *Eruption* being made, *all Illneſs* vaniſhes; except perhaps a little of the *Vapours* in thoſe that are troubled with them; there is nothing more to do, but to *keep Warm*, drink proper Teas, eat Gruel, Milk Pottage, Panada, Bread, Butter, and almoſt any thing equally Simple and Innocent.

9. Ordinarily the Patient *ſits* up every Day, and entertains his Friends. yea, ventures upon a *Glaſs of Wine* with them. If he be too Intent upon hard *Reading* and *Study*. we take him off.

10. Sometimes, tho' the Patient be on other Accounts eaſy enough, yet he *can't Sleep* for divers Nights together. In this Caſe we do not give him *Anodynes* or *Opiates*, becauſe we find, That they who have taken theſe Things in the *Small Pox* are generally peſtered with miſerable *Biles* after their being recovered. So we *let them alone*; their *Sleep* will come of it ſelf, as their *Strength* is coming on.

11. On the Seventh Day the *Puſtules* uſually come to their Maturity; *and ſoon after* this they go away, as

as thoſe of the *Small Pox* in the *Diſtinct Sort* uſe to do.

12. The Patient gets abroad quickly, and is moſt ſenſibly *Stronger*, and in *better* Health than he was before. The Tranſplantation has been given to *Women in Child-bed*, Eight or Nine Days after their Delivery; and they have got earlier out of their Child-bed, and in better Circumſtances, than ever in their Lives. Thoſe that have had ugly *Ulcers* long running upon them, have had them healed on, and by this *Tranſplantation*. Some very feeble, crazy, *Conſumptive* People, have upon this *Tranſplantation*, grown hearty and got rid of their former Maladies.

13. The *Sores* of the *Inciſion* do ſeem to dry a little in Three or Four Days of the Feveriſh Preparation for *Eruption*. After this there is a *plentiful Diſcharge* at them. The diſcharge may continue a little while after the Patient is quite well on other Accounts; But the *Sores* will ſoon enough dry up of themſelves; but the *later*, the *better*, as we think. If they happen to be *inflamed*, or otherwiſe Troubleſome, we preſently help them in the ways we do any *Ordinary Sores*.

VII. *A Letter from Dr.* Nettleton, *Phyſician at* Halifax *in* Yorkſhire, *to Dr.* Whitaker, *concerning the Inoculation of the* Small Pox.

SIR,

HAVING too often found with no ſmall Grief and Trouble, how little the Aſſiſtance of Art cou'd avail in many Caſes of the *Small Pox*, I was induced to try the Method of Inſition or Inoculation, which came ſo well recommended by ſeveral Phyſicians

cians from *Turkey*, and which had alſo been lately practiſed in *London*. This I thought was ſufficient to juſtify the Attempt, and what ſucceſs it has met with, I have here ſent, according to your deſire, a faithful Account of, and of every Thing that has been done or obſerved here, relating to that Affair, which might be worth your Notice.

It was in *December* laſt, That I firſt began to put this Method in Practice, and finding it to ſucceed beyond my Expectation in the firſt inſtance, I was encouraged to repeat it upon ſome others, and afterwards ſeveral, ſeeing with how much eaſe theſe got thro' the Diſtemper, were deſirous to have the ſame done to themſelves or their Children; ſo that there are now upwards of Forty here, who have received the *Small Pox* by Inſition; who are all got well thro' the Diſtemper, and are at this time thro' Gods Bleſſing in very good Health. Only one that was inoculated, did Die; of which I ſhall give you a particular Relation hereafter, and refer it to your Impartial Judgment, whether that ought to caſt any Blemiſh upon the Operation or no.

What was done by way of Preparation was chiefly purging with Rhubarb for Children, and ſometimes Vomiting or Bleeding for grown Perſons; and many have had no Preparation at all. But I always found, as far as I was able to judge, That thoſe, whoſe Bodies were well prepared by ſuch proper Methods as their different Ages or Conſtitutions did ſeem to require, had more favourable Symptoms than others in like Circumſtances, where that was omitted.

The Method, which I always took in the Operation, was to make two Inciſions, one in the Arm and another in the oppoſite Leg. It is not material as to raiſing the Diſtemper, whether the Inciſions be large

or

or ſmall; but I commonly found, that, when they were made pretty large, the quantity of Matter diſcharged afterwards at thoſe Places was greater; and the more plentiful that Diſcharge, the more eaſy the reſt of the Symptoms generally are, and they are alſo by this means the beſt ſecured fromany inconvenience, which might follow, after the *Small Pox* are gone off.

At firſt I collected ſome of the Matter from the Puſtules of one, who had the *Small Pox* of the natural Sort, into a ſhell or Vial, and infuſed two or three drops of it into the Wound; but finding it to be very troubleſome and difficult to get any quantity of the Matter, and obſerving alſo, that the leaſt imaginable will be ſufficient for the Purpoſe, I commonly take ſmall Pledgets of Cotton, and ripping the Puſtules, when they are ripe, with the point of a Lancet, roll the Pledgets over them, till they have imbibed ſome of the Moiſture. I put one of theſe upon each Wound, and cover it with any common Plaiſter till the next Day, when I commonly take away both the Cotton and the Plaiſter, leaving the Wound to it ſelf, only covering it with a ſlight linnen Roller, to defend it from the Air. I have ſometimes rubb'd the Pledget only once over the Wound, without binding it on, which I found to anſwer the End as well; and from ſome other Obſervations I have made, I have been ſurprized to ſee the *Small Pox* produced this way, when I was very well aſſured, the quantity of Matter received into the Veſſels, cou'd not amount to the hundredth part of a Grain.

The Perſons inoculated have not been confin'd to any Regimen, but only to be kept moderately warm; and thoſe, who were grown up, to live very temperate and regular, to keep their Minds eaſy and com-

and to uſe proper means to drive away all Fear and Concern. Some have been obliged from the time of the Inſition to abſtain from Fleſh and all ſtrong Liquors; but I found afterwards, that the Eruption did not proceed ſo well, when they were obliged to live too low. Perhaps in warmer Climates, where they are not ſo much accuſtomed to live upon Fleſh, ſuch Abſtinence may be neceſſary; but here I find it beſt to let them eat and drink as uſual, tho' ſomething more ſparingly, till the Fever begins to riſe; and then, but not before, we enjoin ſuch a Regimen as is uſual in like Caſes.

The firſt Thing that occurr'd after the Inſition, was the Inflammation of the Wounds, which commonly happen'd about the fourth Day, when they began to appear very red round about, and to grow a little ſore and painful; in about two Days more they began to digeſt and run. In ſome they begin to run ſooner, and the quantity diſcharged is much greater than in others. I generally found, that in thoſe who diſcharged moſt this way, the Fever was more ſlight, and the *Small Pox* fewer, tho' I have known ſome do very well when theſe places have only appear'd very red, but have ſcarce run any thing at all, as it uſually happens, when the Inciſion is made ſo ſuperficial as not to cut thro' the Skin.

About the ſeventh Day the Symptoms of the Fever begin to come on, which are the very ſame, that we always obſerve in the *Small Pox* of the diſtinct Kind, in the natural way. A quick Pulſe, great heat and thirſt, pain in the Head and Back and about the region of the Stomach, vomiting, doſedneſs, ſtartings, and ſometimes Convulſions. All were not ſeized with all theſe Symptoms, nor in the ſame Degree or Continuance; ſome began on the ſeventh Day, and

continued ill without any Remiſſion till after the eleventh; many not till the eighth or ninth Day; and the Fever in theſe was more moderate with great Intermiſſions; and ſome have ſcarce had any illneſs at all. During all this time the Places of Inciſion continued to be very ſore and ſwell very much, ſo as to appear very large and deep, and to diſcharge a great deal of Matter.

On the tenth Day the *Small Pox* moſt commonly did appear, ſometimes on the ninth, and ſometimes not till the eleventh; but I never found that any difference of Age, Conſtitution, or any other Cauſe ever made them vary above one Day from the tenth. The Number was very different, in ſome not above Ten or Twenty, moſt frequently from Fifty to two Hundred, and ſome have had more than could well be numbered; but never of the confluent Sort. Their Appearance was the ſame with thoſe of the diſtinct Kind, they commonly came out very round and florid, and many times roſe as large as any I have obſerved of the natural Sort, going off with a yellow Cruſt or Scab as uſual; tho' it ſometimes happens, eſpecially when the Sores diſcharge a very great quantity of Matter, that they are both few in Number, and do not riſe to any Bulk; but having made their Appearance for Four or Five Days they waſt inſenſibly away.

After the *Small Pox* come out, the Feveriſh Symptoms gradually abate, and when the Eruption is completed, they uſually ceaſe, without any ſecond Fever, or any farther trouble in any reſpect.

While the Puſtules were riſing, and for ſome time after they were gone, the Sores continued to ſwell and to run very much, the longer they did ſo the better; but they never fail'd to heal up of themſelves after a certain Time.

I very rarely ſaw Occaſion for any Medicines in the courſe of the Diſtemper, only ſometimes when the Symptoms ran very high, I gave a gentle Anodyne, to be repeated as Occaſion ſhould require, and once or twice I thought it neceſſary to bliſter, and to uſe ſuch Medicines as are found to be moſt ſerviceable in the *Small Pox* of the natural ſort. After the Puſtules are gone away, they have always been purged twice or thrice, and ſometimes let Blood, which is all that has been uſually done. But tho' the Practice may ſeem to be very eaſy, yet it is an Affair of ſuch a Nature as to require the utmoſt Care, and I preſume it will never be undertaken without the Advice of Phyſicians to direct a proper Method of Preparation before the Inſition is made, as well as a juſt Regimen afterwards; to watch every Symptom, and lend Nature all proper aſſiſtance, when ever it ſhall be requiſite. Where this is done, with Gods Bleſſing, it will ſeldom fail of being attended with happy ſucceſs.

It has happen'd in one Inſtance or Two, That the Symptoms in the Diſtemper have been worſe than uſual; and ſome few, after the *Small Pox* were gone off, have been ſubject to other indiſpoſitions. Of all which I ſhall give you a particular Account.

* The firſt that was Inoculated, a Boy about a Year and half Old, began to be ill on the Eighth Day, and had a briſk Fever for two Days, then the Puſtules began to appear, which were but few in Number, and roſe very large. The Child was ſoon well, and continued ſo for about a Month, when being carryed out and kept a long Time in the Cold, he fell into a Feveriſh diſorder accompanied with a Cough, and was

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* *Thomas Thorp*'s Son of *Hallifax*.

was ill for Four or Five Days; after that time it went off, and he has ever ſince been in very good Health.

* The Second was a Girl two Years of Age, in a Family where they had formerly Bury'd three Children ſucceſſively of the *Small Pox*, and this they fear'd might undergo the ſame Fate. The Fever came on about the ſeventh Day, and ſhe continued very ill till the tenth, on which Day about Noon ſhe had a ſtrong convulſive Fit. In the Evening the *Small Pox* appear'd, and tho' ſhe had more in Number than uſual, yet ſhe grew well as ſoon as they were fully come out, and has continued ſo ever ſince.

† The Eighth and Ninth were in a Family where they had four Children, none of whom had had the *Small Pox*. I was call'd to the Eldeſt, who was ſeized in the natural way with the moſt malignant Sort I ever ſaw, attended with the worſt Symptoms that cou'd be, inſomuch that he died on the fourth Day, all full of purple and livid ſpots. The Parents were very deſirous, that any means might be uſed to preſerve the reſt; but here I was in great doubt and perplexity what part to act. I knew very well, That if I ſhou'd venture to make the Inſition, whatever ſhou'd happen wou'd be charged upon that, and it was not improbable, but ſome of them might have already taken the Infection, in which Caſe it was uncertain what the event might be. On the other Hand, if it was omitted, I did very much fear they might all Dye, ſuch inſtances having been known, and the Contagion which was got amongſt them, being of ſuch a deſtructive

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* *Jer. Turner*'s Daughter.
† Mr. *John Symſon*'s Children.

ſtructive Nature. Wherefore I was willing to run the riſque of my Reputation, rather than that the Children ſhou'd all periſh. They were therefore all three inoculated the Day before the eldeſt died, after having told the Parents that I cou'd not anſwer for the Succeſs, in Caſe they had already catch'd the Infection, which would be known if any of them fell ill before the Seventh Day. According as we fear'd, one of them began on the ſecond Day, much after the ſame Manner with the Eldeſt, and the *Small Pox* appear'd on the third Day, or rather an univerſal redneſs all over the Skin, interſperſed with many purple ſpots. There were none of theſe ſpots near the Places of Inſition, which began to ſwell a little, as uſual about the fourth Day, and the *Small Pox* did riſe a little more about thoſe Places than elſewhere; but Nature was too far oppreſs'd with the violence of the Diſtemper, and tho' this Girl continued longer than her Brother, and was not delirous as he was, yet ſhe died on the ſeventh Day. I did not reckon this Child in the Number of thoſe who received the Diſtemper by Inoculation; for I thought there was ſufficient Reaſon to conclude, that ſhe had taken the Infection before; but of this I muſt leave you to judge as you pleaſe, I only give you a Relation of Facts. The other two continued well till the eighth Day, when they both fell ill together. The *Small Pox* came out on the tenth, of a very good Sort, tho' more in Number than ſome others had. and they both got very eaſily thro' the Diſtemper without any Indiſpoſition ſince. It was obſervable, that the Elder of theſe Children, about the time of the Eruption, had many Spots appear'd on him of a deep red Colour, very much like thoſe of the other two Children, which changed in them to Purples afterwards, which

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the Mother was very much concern'd at, fearing they wou'd prove the ſame in this; but when the *Small Pox* came out, theſe Spots grew gradually leſs, and at laſt quite diſappear'd The other Child had been very ſubject to Convulſions for a long Time, when very young, and it was afflicted with the ſame very much, from the Time that the Fever came on, till the *Small Pox* appear'd.

* The Twenty Seventh was a marry'd Gentlewoman aged about Twenty Six; who got very well thro' the Diſtemper; but about a Week after was ſeized with a very great Coldneſs and Shivering, which were followed by a burning Heat, with a great Pain and Diſorder in her Head, which continued for ſeveral Hours. She had ſome time ago an intermitting Fever, which I took this to be a Paroxyſm of, and expected its return; bnt ſhe felt no more of it, and has ever ſince continued in good Health.

Of her two Sons, who were both inoculated at the ſame Time, the Younger got thro' the Diſtemper with a great deal of eaſe, the *Small Pox* being few, and the Symptoms very ſlight; but the Elder a Boy about five Years old, fared quite otherwiſe. The Symptoms before the Eruption were more than uſually ſevere, eſpecially the Vomiting; the Puſtules appear'd at the uſual Time, but more numerous than ordinary, and when the Eruption was finiſh'd, the Fever did not ceaſe, as it has done in every inſtance but this: on the fifth Day after he was ſeized, the ſwelling of his Face began, which was follow'd by a Pain and Swelling in his Throat, and a Salivation, which continuing till the eleventh Day, were ſucceeded by a Swelling

* Mrs. *Breara* of *Eland*.

Swelling in his Hands and Feet, the uſual Symptoms of the diſtinct Sort when they are very full; and tho' there appear'd ſome little Signs of Malignity, yet with the Uſe of Bliſters and the milder Cordials and Alexipharmicks, the Puſtules roſe very large, and all Things went on very well, ſo that he got thro' the Diſtemper without any Danger, but with much more Pain and Trouble than any of the reſt have endured. After the *Small Pox* were gone off, we found a hard Swelling upon his Shoulder, which diſabled him for ſome time from moving his Arm; but by the Uſe of ſome common Applications, that is entirely gone. In this Family the only Child they had before theſe, died of the *Small Pox*, of a very malignant ſort, and this Boy was of an ill habit, and has had many dangerous illneſſes.

* The Twenty Third, was a Girl about Nine Months old; in this Child, after ſhe was well of the *Small Pox*, the Mother diſcover'd that one of her Thighs was a little ſwell'd, which was painful to her for ſome time, and made her unwilling to move that part; there were alſo ſome ſmall Tumours in the Groin; but theſe went off in a few Days, there only remaining a hardneſs about the Knee, which alſo diſappear'd in a ſhort Time without coming to Suppuration, and the Child is now in perfect Health.

† The Thirty Seventh was a Girl ſix Years of Age; ſhe got very eaſily thro' the Diſtemper; but before the *Small Pox* were gone, we found a ſmall Tumor upon the Muſcles of the Loins, which ripen'd very ſpeedily, and was open'd and heal'd up in a very ſhort time. Her Siſter, a young Woman about Eighteen

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* Mr. *Js. Hanſon*'s Daughter.
† Mr. *John Haigh*'s Daughters.

teen had alſo a Swelling of the ſame Kind in her Leg, but it lay ſomething deeper, and gave her a great deal of Pain for Three or Four Days; afterwards it diſcharged a great quantity of Matter, and was heal'd without any farther Trouble.

All the reſt, excepting theſe I have mentioned, got very well thro' the Diſtemper without any manner of Trouble, or Hazard, or any ill Conſequence afterward. Whether thoſe ſlight Indiſpoſitions, which ſome have been ſubject to afterward, were owing to the Inſition, I have not been able to judge; but I preſume what they have endured in the Courſe of the Diſtemper, and what has followed after, is not to be put in the Ballance with what is undergone in the common way, by thoſe who are thought to come off very well; and if this Method were more generally practiſed, 'tis probable ſome means wou'd be found out, to prevent even theſe ſubſequent diſorders, which are no more frequent, nor near ſo bad, as thoſe which follow the natural Sort.

In two Inſtances the Inoculation had no effect, the Reaſon of which, in one, * was becauſe the Child had the *Small Pox* before, as the Parents did believe; but the Diſtemper had been ſo favourable, as to leave it doubtful. † In the other, the Matter was taken, when the Puſtules were wither'd, and almoſt gone, and that little moiſture which they contain'd, I ſuppoſe, had loſt its Virtue; the Boy to whom it was made uſe of, was no way affected; the Places of Inciſion did not at all inflame, or ſwell as uſual, nor did any Puſtules appear; but about a Month after, he was ſeized with

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* *Mich. Bland's* Daughter.
† *William Clark's* Son.

the Diſtemper in the ordinary way, and did very well

Some of thoſe who have been inoculated, that are grown up, have afterwards attended others in the *Small Pox*, and it has often happen'd, that in Families where ſome Children have been inoculated, others have been afterwards ſeized in the natural way, and they have lain together in the ſame Bed all the Time; but we have not yet found, that ever any had the Diſtemper twice; neither is there any Reaſon to ſuppoſe it poſſible, there being no difference that can be obſerved, betwixt the Natural and Artificial Sort, (if we may be allow'd to call them ſo) but only that in the latter the Puſtules are commonly fewer in Number, and all the reſt of the Symptoms are in the ſame proportion mote favourable. There is one Obſervation which I have made, tho' I wou'd not yet lay any great ſtreſs upon it, that in Families where any have been inoculated, thoſe who have been afterwards ſeized, never had an ill ſort of *Small Pox*, but always recovered very well.

Thus, Sir, I have given you a ſhort and plain Account of what has occurr'd to me concerning this Method of Inoculation: 'tis not any pains or care I have taken in writing this Letter, that can recommend it, for I have been ſolicitous about nothing but Truth, my deſign being only to give you a ſhort Hiſtory of the Diſtemper raiſed by Inoculation, ſo far as I have obſerved it. The Number might perhaps have been greater, if I wou'd have preſs'd it; but I only took ſuch as deſired it of themſelves, being cautious of perſwading any Body to it, becauſe I had but little Authority hereabouts to ſupport me; tho' I ought to acknowledge the kindneſs of many of my Friends, who being convinced, that this Method would be

of

of ſome uſe, were very zealous to promote it; and in particular that very learned and worthy Gentleman, Dr. *Richardſon*, did upon all Occaſions vindicate this Practice. I know not whether I ſhall have an opportunity of doing much more this way at preſent, the *Small Pox* being in a great meaſure gone from this Town and Countrey; but I have already ſeen ſo much of it, that I ſhou'd never be afraid of its ſucceſs.

There is only one Thing more I am obliged to mention, which I wou'd rather have paſs'd over in ſilence, and that is the vigorous oppoſition it has met with from many honeſt well meaning Perſons, who cou'd not but fancy, that it is an unlawful and unwarrantable Practice. They have gain'd a great Majority on their ſide here, at well as in other Places, where it has been practiſed. I only wiſh, that, as they act upon a principle of Conſcience, they wou'd have been leſs buſy in raiſing, or ſpreading falſe and groundleſs Reports, whereby this Matter has been very much miſrepreſented, and many, entertaining a wrong Notion of it, have been deterr'd from making uſe of this Method for themſelves or their Children, who have ſince been unhappily taken off by the *Small Pox*. But when this Affair is ſet in a true light, and found to be always ſafe and effectual, I believe all the Objections raiſed againſt it will fall of courſe. It wou'd be of the greateſt moment that the World ſhou'd know what you think of it in Town, and how you have found it to ſucceed; 'tis commonly objected here, that it is not approved of in *London*; but if thoſe Gentlemen, who have juſtly gain'd the greateſt Honour and Reputation in our Profeſſion, ſhou'd by finding it ſucceſsful ſee cauſe to declare publickly in its favour, that wou'd be the greateſt means to

forward it in the Country, and to remove thoſe unreaſonable prejudices, which do generally prevail againſt a Method, which I believe has no where been put in practice with any other Aim than to do ſome ſervice to Mankind: for which Reaſon I doubt not but this ſhort Narrative will be acceptable unto you from, &c.

Thomas Nettleton.

Halifax, Apr. 3. 1722.

VIII. A

VIII. *A Letter from the ſame Learned and Ingenious Gentleman, concerning his farther Progreſs in inoculating the* Small Pox: *To Dr.* Jurin R. S. Secr.

IN Anſwer to what you require from me, as to what has been farther done, I have only to add that ſince I writ to Dr. *Whitaker*, I have made the Inſition upon about fifteen Perſons, who have all had the Diſtemper very favourably, and got thro' it with a great deal of eaſe. As nothing uncommon or extraordinary did happen in any of theſe Caſes, it will not be neceſſary to trouble you with a particular Account of any of them: They were moſt of them at ſome diſtance, the *Small Pox* being in a great meaſure gone from this Town and Neighbourhood.

I am very ſenſible of the Favour done me by the Royal Society, who were pleaſed to take notice of my Letter to Dr. *Whitaker*, which you had nothing to move you to beſides a generous Diſpoſition to encourage the ſmalleſt attempts towards any Thing, that may tend to publick Advantage. I muſt own that all the Information I had concerning this Affair, which I have happen'd to be engaged in, was entirely from the *Philoſophical Tranſactions*. 'Tis now about ſix Years ſince the Royal Society did communicate to the World ſome Letters from two very conſiderable Phyſicians reſiding in *Turkey*, whoſe good Senſe or Integrity we had no Reaſon to call in queſtion; theſe Gentlemen did ſo-

ſolemnly

lemnly assure us, that the Method of Inoculation had been for many Years practised in those parts of the World, with almost constant success. I had, as well as all others who have been engaged in the Practice, with sufficient Sorrow and concern, been called to many in the *Small Pox*, whose Cases were so deplorable, as to admit of no relief. And therefore I cou'd not but be very thoughtful about this Method, which promised to carry Persons thro' that cruel Distemper, with so much ease and safety. I was so far from knowing that it was a Crime, that I always thought it the Duty of our Profession, to do whatever we could to preserve the Lives of those, who commit themselves to our Care; And I knew no Reason, why we ought not, with all humble thankfulness to Almighty God, to make use of any means, which his good providence shall bring to light conducing to that End. This Matter, tho' of so great Importance, lying dormant so long after it was known, is, I presume a sufficient proof, that none have been very forward to try Experiments. But when we had the Account in the Publick Papers, that it had by their Royal Highness's Command been done with success at *London*, I cou'd not be satisfied without trying it here. I was soon convinced, that it would be of very great use; and the more experience I have had of it since, the more I am confirm'd in the same opinion. I believe all others, who have seen any thing of this Practice, are in the same sentiment, and there is no doubt, but in a few Years the World will acknowledge the service, which the Royal Society have done to Mankind, in first revealing to this part of *Europe* a Thing so beneficial as it will certainly prove; for tho' some few unfortunate accidents may sometimes happen, yet those will be very rare in comparison of the many sad and disastrous

Events

Events, which this Diſtemper has been, and ever will be very fruitful of, while it is left to rage in its full force and violence.

Sir, I doubt not but when you have collected a ſufficient Number of Obſervations for it, you will be able to demonſtrate, That the Hazard in this Method is very inconſiderable, in proportion to that in the ordinary way by accidental Contagion, ſo ſmall, that it ought not to deter any Body from making uſe of it. In order to ſatisfy my ſelf, what Proportion the Number of thoſe that die of the *Small Pox*, might bear to the whole Number that is ſeized with the Diſtemper, in the natural way, I have made ſome enquiry hereabouts, and I ſhall take the freedom to tranſmit the Accounts to you, becauſe I believe you may depend upon their being taken with ſufficient care and impartiality. In *Halliſax*, ſince the beginning of laſt Winter, 276 have had the *Small Pox*, and out of that Number 43 have died. In *Rochdale*, a ſmall Neighbouring Market Town, 177 have had the Diſtemper, and 38 have died. In *Leeds* 792 have had the *Small Pox*, and 189 have died. It is to be noted, that in this Town, the *Small Pox* have been more favourable this Seaſon than uſual, and in *Leeds* they have been more than uſually mortal; but upon a *Medium* in theſe three Towns, there have died nearly 22 out of every hundred, which, is above a *fifth Part*, of all that have been infected in the natural way. I have in theſe Accounts confined my ſelf to the Limits of the Towns. The Numbers that have had the *Small Pox* in the Country round about, is vaſtly greater; but the Proportion of thoſe that die is much the ſame. I have made the enquiry in ſeveral Country Villages hereabouts,

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in ſome I found the Proportion to be greater, in others leſs, but in the main it is nearly the ſame. I am, *&c.*

Thomas Nettleton.

Halifax
June 16. 1722.

FINIS.

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PHILOSOPHICAL TRANSACTIONS.

For the Months of *April* and *May*, 1722.

Jos. Banks

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N. B. The Meridional Distance is reckon'd from St. *Jago.*

Month and Year.	Latitudes.	Meridian Distance.	Longitud.	Variation.
August 24th 1721.	9° 8′ Sou.	9° 23′ W.	9° 25′ W	2° 13′ E
Ditto 26	11° 12′ S.	10° 46′ W	10° 50′ W	4° 30′ E
Ditto 27	11° 34′ S.	11° 28′ W	11° 41′ W	4° 29′ E
Ditto 28	12° 32′ S	11° 31′ W	11° 43′ W	4° 27′ E
Ditto 31	15° 46′ S	10° 53′ W	11° 6′ W	6° 10′ E
Septemb. 2d.	16° 26′ S	8° 25′ W	8° 30′ W	7° 16′ E
Ditto 5th	18° 45′ S	9° 31′ W	9° 39′ W	6° 17′ E
Ditto 6	19° 47′ S	9° 10′ W	10° 0′ W	8° 6′ E
Ditto 17	28° 43′ S	1° 7′ W	1° 9′ E	5° 53′ E
Ditto 22	31° 33′ S	3° 41′ E	3° 56′ E	4° 10′ E
Ditto 27	33° 30′ S	11° 29′ E	12° 57′ E	0° 11′ W
Ditto 30	32° 40′ S	19° 6′ E	12° 1′ E	3° 0′ W
October 1st,	32° 53′ S	21° 18′ E	24° 59′ E	5° 41′ W
Ditto 3	32° 30′ S	25° 33′ E	30° 0′ E	7° 47′ W
Ditto 5	32° 28′ S	30° 37′ E	35° 52′ E	8° 44′ W
Ditto 6	31° 22′ S	31° 40′ E	37° 7′ E	10° 57′ W
Ditto 7	31° 11′ S	32° 4′ E	37° 47′ E	11° 20′ W

Obser-

Observations on the Coaſt of Africa.

Month and Year.	Latitudes.	Meridian Diſtance.	Longitud.	Variation.
October 13*th*, 1721.	26° 17′ S.	35° 35′ E	41° 41′ E	14° 30′ W
Ditto 19	19° 41′ S			12° 22′ W
Ditto 21	17° 4′ S			14° 29′ W
Ditto 25	13° 56′ S			14° 48′ W
November 4*th*,	10° 57′ S			13° 11′ W
Ditto 7	8° 19′ S			15° 14′ W
Ditto 29	5° 0′ S	in *Cabenda-Bay.*		14° 33′ W

Fr om *Cabenda* to *London*, Merid. Diſtance from thence.

December 9*th*,	3° 25′ S	11° 38′ W	11° 43′ W	11° 32′ W
Ditto 14	3° 30′ S	21° 18′ W	21° 24′ W	
Ditto 20	0° 30′ S	30° 41′ W	30° 46′ W	1° 5′ W
January 1 172½.	10° 50′ N	39° 8′ W	39° 16′ W	1° 1′ E
Ditto 6	17° 15′ N	43° 21′ W	43° 29′ W	1° 41′ E

II. *A Letter to Dr.* Mead, *Coll. Med.* Lond. *&* Soc. Reg. S. *concerning an Experiment, whereby it has been attempted to ſhew the falſity of the common Opinion, in relation to the force of Bodies in Motion. By* Henry Pemberton, *M. D.* R. S. S.

SIR,

PEruſing the Learned *Polenus*'s Tract *de Caſtellis*, you were pleaſed to ſend me; I have found in it ſeveral curious Experiments, among which I reckon that of letting Globes of equal Magnitude, but of different weights, fall upon a yielding Subſtance, as Tallow, Wax, Clay or the like, from heights reciprocally proportional to the weights of the Globes. This Experiment engaged in particular my Attention, as it is brought with deſign to overturn one of the firſt Principles eſtabliſh'd in Natural Philoſophy. And the Knowledge I have of your great Eſteem for that part of Science, emboldens me to trouble you with my Thoughts upon this Experiment; for I cannot by any means admit of the Deduction that is drawn from thence, that becauſe the Globes make in this Experiment equal Impreſſions in the yielding Subſtance, therefore they ſtrike upon it with equal force: whereby it is attempted to prove the Aſſertion of Mr. *Leibnitz*, that the force of the ſame Body in deſcending is proportional to the height from whence it falls; or, in all Motion, proportional to the Square of the Velocity, and not proportional to the Velocity it ſelf, as is commonly thought. On the contrary, I think this very Experi-

ment proves the great unreaſonableneſs of Mr, *Leibnitz*'s Notion.

I am ſurpriz'd, that ſo careful a Writer as *Polenus* appears to be, from the accuracy wherewith he delivers his Experiments, ſhould not rather ſuſpect his reaſoning in an intricate Caſe, than thus contradict a Principle in Philoſophy, that has been directly prov'd by a multitude of Experiments, in particular by thoſe Sir *Iſaac Newton* recommends for that purpoſe (*a*); and that is moreover abundantly eſtabliſh'd by its exact Agreement with all Obſervations; as being the Principle upon which all appearances, hitherto obſerved in the motion of Bodies, are accounted for by juſt and undeniable Arguments; and we ſhall find on Inquiry, that the preſent Caſe comes alſo under the ſame Rule.

As the uſe of Experiments in Natural Philoſophy is to diſcover the Cauſes of Things, by exhibiting more ſimple Effects of thoſe Cauſes, than occur in the ordinary courſe of Nature; ſo for this end it is neceſſary, that our Argumentation upon Experiments be perfectly juſt, otherwiſe they may lead us into Errors. The firſt thing neceſſary for making right Deductions from an Experiment, is to determine the proper uſe thereof; which I think in this before us is not rightly underſtood. Certainly this Experiment of *Polenus* is much more fit to inform us of the Law, by which theſe yielding Subſtances reſiſt the motion of Bodies ſtriking upon them, than to ſhew the forces, with which Bodies ſtrike; for whatever thoſe forces be, the Effects muſt be very different, according to the Difference there may be in the Rule obſerved by ſuch reſiſtance.

(*a*) Princip. Philoſ. Nat. *p.* 19.

Now

Now this Experiment ſhews, that if two Globes in Motion bear againſt equal Portions of the yielding Subſtance, the Oppoſition, that Subſtance makes to the Motion of the Globes, will be the ſame in both, however different the Velocities be, with which they move. This I ſhall demonſtrate as follows.

Let *A* and *B* be two Globes, equal in Magnitude, but of different Weights, which are equally immerſed into a yielding Subſtance. Suppoſe the Velocities, with which they move in their preſent Situation, to be reciprocally in the Subduplicate *ratio* of the Weights of the Globes; that is, let the *ratio* of the Weight of the Globe *A* to the Weight of the Globe *B*, be Duplicate of the *ratio* of the Velocity of the Globe *B*, to the Velocity of the Globe *A*. Since therefore the *ratio* of the quantity of Motion in the Globe *A*, or of the force with which it moves, to the quantity of Motion in the Globe *B*, or to the force with which that Globe moves, is compounded of the *ratio* of the Weight of the Globe *A*, to the Weight of the Globe *B*, and of the *ratio* of the Velocity of the Globe *A*, to the Velocity of the other Globe *B*, the force, with which the Globe *A* moves, is to the force, with which the Globe *B* moves, as the Velocity of this Globe *B*, to the Velocity of the other Globe *A*. But if the ſame Oppoſition be made to the Motion of the Globes, when they bear upon equal Portions of the yielding Subſtance, the Effect of that Oppoſition, while the Globes enter farther into the Subſtance by equal Spaces, will be proportional to the time, in which the Globes are moving thoſe Spaces, or in which the Oppoſition is made, if we conſider thoſe Spaces while naſcent or in their firſt Origine; the Effect therefore of this Oppoſition will be reciprocally proportional to the Velocity of each Globe: namely, the momentaneous loſs of force in the Globe

A will be to the momentaneous loſs of force in the Globe *B*, as the Velocity of the Globe *B*, to the Velocity of the Globe *A*; and the whole force of the Globe *A* has been found to bear the ſame *ratio* to the whole force of the Globe *B*; conſequently theſe Globes, while they penetrate equal Spaces into the Subſtance, loſe parts of their force, which bear the ſame proportion to the whole: and therefore, if their Velocities be at any time reciprocally in the Subduplicate *ratio* of their Weights, ſo that the forces or degrees of Motion, with which they move, be reciprocally proportional to their Velocities, the forces, with which they preſs into the yielding Subſtance, at equal Indentures made in the Subſtance, will continue in the ſame Proportion; and therefore upon the Theory of Reſiſtance here ſuppoſed, when the whole Force and Motion of both theſe Globes is entirely loſt, they will be plunged into the Subſtance at equal Depths.

Now whereas in the Experiment of *Polenus*, the Globes, falling from Heights reciprocally proportional to their Weights, ſtrike upon the yielding Subſtance with Velocities reciprocally in the Subduplicate proportion of their Weights, and the Effect is in all Caſes found to be, what is here deduced from the Theory of Reſiſtance, I have propoſed; it is a ſufficient Confirmation of the Truth of this Theory.

Only here, Sir, I ought to obſerve to you, That I have ſuppoſed the Globes to be ſtopt by the whole Reſiſtance of the Subſtance, they move againſt; although in ſtrictneſs they are ſtopt only by the exceſs of that Reſiſtance above the Action of Gravity upon them. But I have neglected the Conſideration of the Action of Gravity, that being but ſmall in Proportion to the Reſiſtance, as will appear from the Globes being much more ſpeedily ſtopt by this Reſiſtance, than they

they would be by the Action of Gravity, if its force were applied upwards; for by that force alone, the Globes would not be ſtopt, till they had meaſured Spaces equal to the heights above the reſiſting Subſtance, from whence they fell; which heights bear a great Proportion to the depths, the Globes in this Experiment are immerſed into the yielding Subſtance, as I have found upon trial.

Thus, if I miſtake not, may be removed the Difficulty attending this Experiment. But as Mr. *Leibnitz*'s Opinion is deduced from it by Means of this Axiom, that Effects are proportional to their Cauſes; ſo that here the Effects being thought the ſame, the Cauſes are concluded to be ſo likewiſe; it will not be amiſs to mention in this place an Experiment, where this Axiom may be more juſtly applied, than it can be in our preſent caſe, from which Experiment the received Opinion may be proved. This Experiment is mentioned by *Polenus* from *Merſennus*, though tried by him ſomewhat rudely; but has been often ſince made in the following manner. To one end of the Beam of a Ballance is hung a Weight, and from a proper height is let fall upon the other extremity of the Beam another Weight, which by ſtriking thereon ſhall raiſe the end, to which the Weight is ſuſpended, to ſuch a height, as is juſt ſufficient to ſet free a certain Spring. If then a different Weight be hung in the room of the former; the height, from whence the falling Weight muſt deſcend, in order to raiſe the Extremity of the Ballance, to which this other Weight is ſuſpended, to the ſame height as before, that is, high enough to ſet the forementioned Spring at liberty, is found to be ſuch, that the Velocity, with which the falling Weight ſtrikes upon the Ballance, in this latter Caſe, will be to its former Velocity, as the latter Weight

to

to the former, (*a*) except only that, agreeably to what *Merſennus* himſelf remarked, when the Weight deſcends from great heights, an Altitude ſomewhat greater than this Rule implies is required to raiſe the other Weight as much as is deſired. But whether the bending of the Arm of the Ballance, when acted upon with a great force, or whether any increaſe of Friction in this Caſe, occaſion the Irregularity here mentioned, we need not ſtrictly enquire; for this Irregularity is yet leſs reconcileable with the new Opinion, than the regular Effects of the Experiment. Hence therefore we may ſee, that the very Method of reaſoning, which being applied erroneouſly, is ſuppoſed to prove Mr. *Leibnitz*'s Sentiment concerning the force of Bodies in Motion, will, when juſtly uſed, confirm the other Opinion in relation to that Matter.

But as I have aſſerted in the beginning of this Letter, that the very Experiment of *Polenus* is not only reconcileable to the common Doctrine of Motion, as I have now demonſtrated; but even that it does it ſelf make manifeſt the great unreaſonableneſs, if not the abſolute Abſurdity, of Mr. *Leibnitz*'s Opinion; it remains that I briefly make proof of this.

If two Globes *A* and *B*, of equal Magnitude but of different Weights, ſtriking on a yielding Subſtance with equal force, in every Caſe loſe all their Motion at equal Depths, it is neceſſary that at all times, during their Motion, they loſe equal Degrees of force, when they bear upon equal Portions of the Subſtance, in entring equal Spaces into the Subſtance. This will be eaſily ſeen from what has before been ſaid. Now whereas Mr. *Leibnitz* ſuppoſes the power of Gravity to

(*a*) *Vid.*'s Graveſande Phyſic. Elem. Tom. I. p. 39.

give

give to the ſame falling Body Degrees of force proportional to the height from whence it falls; according to his Opinion, by the power of Gravity, equal Degrees of force are added in the deſcent of the ſame Body through equal Spaces; and in different Bodies deſcending through equal Spaces, the Degrees of force added will be as the quantity of Matter, or as the weight of each Body. Therefore while the Globes *A* and *B* penetrate equal naſcent Spaces into the yielding Subſtance, by the Action of Gravity, were not that Action overcome by the Reſiſtance of that Subſtance, additional Degrees of force would be communicated in ſuch proportion, that the force added to the Globe *A*, would be to the force added to the Globe *B*, as the weight of the Globe *A*, to the weight of the Globe *B*, or in the Duplicate *ratio* of the Velocity of the Globe *B*, to the Velocity of the Globe *A*. But ſince the Globes loſe the ſame Degrees of force in entring equal Naſcent Spaces into the yielding Subſtance, the Effect of the Oppoſition made by this Subſtance to the Motion of the Globes, during the time of their paſſing through ſuch Naſcent Spaces, will be both the taking from them that ſame Degree of force, and moreover the additional force, which would otherwiſe have been given them by their own Gravity. But farther, the Oppoſition made to the motion of the Globe *A*, to the Oppoſition made to the motion of the Globe *B*, will be in the *ratio* compounded of the *ratio* of the Effect of the Oppoſition, the Subſtance makes to the motion of the Globe *A*, to the Effect of the Oppoſition, the Subſtance makes to the motion of the Globe *B*, and of the *ratio* of the Time, in which the Oppoſition is made againſt the latter Globe, to the Time in which it is made againſt the former; which latter *ratio* is the

ſame

ſame with the *ratio* of the Velocity of the Globe *A*, to the Velocity of the Globe *B*. But ſince it is ſhewn, that the Effect of the Oppoſition made by the yielding Subſtance to theſe Globes is two-fold, and that one part of the Effect of the Oppoſition made to the motion of the Globe *A*, is equal to one part of the Effect of the Oppoſition made to the motion of the Globe *B*; and that another part of the Effect of the Oppoſition made to the motion of the Globe *A*, to another part of the Effect of the Oppoſition made to the motion of the Globe *B*, is in the Duplicate *ratio* of the Velocity of the Globe *B*, to the Velocity of the Globe *A*. One part of the Oppoſition it ſelf made to the motion of the Globe *A*, will be to one part of the Oppoſition againſt the motion of the Globe *B*, as the Velocity of the Globe *A*, to the Velocity of the Globe *B*, and another part of the Oppoſition to the motion of the Globe *A*, to another part of the Oppoſition to the motion of the Globe *B*, will be as the Velocity of the Globe *B*, to the Velocity of the Globe *A*. So that when the Globes bear upon equal Portions of the yielding Subſtance, the Oppoſition to their Motion will be in part as the Velocity of the Globes, and in part reciprocally as their Velocity. Hence, becauſe the reſiſting Subſtance is of an uniform Texture, the Oppoſition to the Motion of either of the Globes in its preſent Situation, and when moving with its preſent Velocity, will be to the Oppoſition it would meet with in the ſame Situation, if it moved with any other Velocity, partly as the preſent Velocity to that other Velocity, and partly as that other Velocity to the preſent. But by that part of the Oppoſition made againſt the motion of the Globe, which is directly as the Velocity, the Globe can never be wholly ſtopt; for upon the ſtopping of the Globe, that part of the Oppoſition

tion to its Motion will likewiſe totally ceaſe, and conſequently the Globe's Weight will carry it further down, unleſs the other part of the Oppoſition againſt its Motion prevent it. But I ſay again, neither can this latter part of the Oppoſition made to its Motion be ever great enough to ſtop the Globe; for the Degree of this Oppoſition being reciprocally as the Velocity of the Globe, when the motion of the Globe is wholly taken away, it will become infinitely greater, than at any time, while the Globe is in Motion; ſo that when the Globe ſhould be ſtopt by this part of the Oppoſition made to its Motion, the Oppoſition to the Globe's Motion will become infinitely great; inſomuch, that no Degree of force whatever could be able to impel the Globe further into the Subſtance, but this can never come to paſs. Beſides, it is not neceſſary to apply any ſuch refined Argument againſt this part of the Reſiſtance; it would be alone ſufficient to conſider, how unreaſonable a Suppoſition it is, that a Reſiſtance ſhould increaſe, when the Velocity of the reſiſted Body decreaſes.

Thus may this Experiment be made uſe of to invalidate that very Opinion it is brought to ſupport. But another uſe may likewiſe be made thereof: For it will ſerve to illuſtrate what the great Sir *Iſaac Newton* has more than once hinted, that the Reſiſtance of Fluids, which ariſes from the Tenacity of their Parts, decreaſes in a leſs Proportion than the Velocity of the reſiſted Body decreaſes *(a)*; for as this Reſiſtance bears a great Analogy to the Reſiſtance of the yielding Subſtances we have been here treating of, ſo we have found, that the Reſiſtance of theſe Subſtances does

(*a*) *Vid.* Philoſ. Nat. Princip. Math. Prop. 52. lib. 2. in Schol. Opticks. Qu. 28. p. 339, 340.

not much depend upon the Velocity of the Body, againſt which the Reſiſtance is applied.

And thus, Sir, we may ſee how all Experience conſpires in confirming and ſetting forth that ſtupendious force of reaſoning, which has enabled our great Philoſopher moſt ſurprizingly to ſearch out, and diſtinguiſh the Springs of Natural Operations; a Work infinitely more difficult to accompliſh than even the great Improvements he has made in pure Mathematicks, which were previouſly neceſſary in order to his ſucceeding in his Searches after the Knowledge of Nature; for in this laſt Purſuit he has given Proof, not only of a more unbounded Invention, than is required in the ſubtileſt Geometrical Speculations; but has alſo there diſcovered the greateſt Diſcernment, and moſt conſummate Judgment; ſince in his Philoſophical Writings, he has never been once impoſed on by an Hypotheſis, nor by any other of the various Fallacies, which my Lord *Bacon* in his *Novum Organon*, has reckon'd up as the Cauſes, that had hindred the Improvement of the true Philoſophy.

But here I ſhall put an end to this long Letter; for the Freedom of which, I know, I need make no Apology to you, Sir, of whoſe great Candour I have for ſome Years paſt been a conſtant Witneſs; and as I have frequently admired, how amidſt the vaſt Employments of your Profeſſion, you ſhould find time to purſue with ſo great Succeſs ſuch various ſorts of Learning; ſo I have as often been delighted to obſerve with what Benignity you receive thoſe, who have made any the leaſt part of uſeful Knowledge their Study.

I am, Sir, &c.

H P.

POST-SCRIPT.

ABout a Week after I had ſent you the Letter, containing my Obſervations on *Polenus*'s Experiment, I had the good Fortune to hear an excellent and learned Friend of yours, to whom you had been pleaſed to ſhew my Letter, give a very curious and weighty Argument to confirm Sir *Iſaac Newton*'s Sentiment in relation to the Reſiſtance of Fluids, which I had deduced from the above mentioned Experiment; and as this very much pleaſed me, I ſhall here endeavour to ſend you an Account of it in the following manner:

Suppoſe pieces of fine Silk, or the like thin Subſtance, extended in Parallel Planes, and fixt at ſmall Diſtances from each other. Suppoſe then a Globe to ſtrike perpendicularly againſt the middle of the outermoſt of the Silks, and by breaking through them to loſe part of its Motion. If the pieces of Silk be of equal Strength, the ſame Degree of force will be required to break each of them; but the Time, in which each piece of Silk reſiſts, will be ſo much ſhorter as the Globe is ſwifter; and the loſs of Motion in the Globe conſequent upon its breaking through each Silk, and ſurmounting the Reſiſtance thereof, will be proportional to the Time, in which the Silk oppoſes itſelf to the Globe's Motion; inſomuch that the Globe by the Reſiſtance of any one piece of Silk will loſe ſo much leſs of its Motion as it is ſwifter. But on the other Hand, by how much ſwifter the Globe moves,

ſo many more of the Silks it will break through in a given Space of Time; whence the number of the Silks, which oppoſe themſelves to the Motion of the Globe in a given Time, being reciprocally proportional to the Effect of each Silk upon the Globe, the Reſiſtance made to the Globe by theſe Silks, or the loſs of Motion, the Globe undergoes by them in a given Time, will be always the ſame.

Now if the Tenacity of the Parts of Fluids obſerves the ſame Rule as the Coheſion of the Parts of theſe Silks; namely, That a certain Degree of force is required to ſeparate and diſunite the adhering Particles, the Reſiſtance ariſing from the Tenacity of Fluids muſt obſerve the ſame Rule as the Reſiſtance of the Silks, and therefore in a given Time the loſs of Motion, a Body undergoes in a Fluid by the Tenacity of its Parts, will in all Degrees of Velocity be the ſame; or in fewer Words, that part of the Reſiſtance of Fluids, which ariſes from the Coheſion of their Parts, will be Uniform.

III. *An*

III. *An Account of the Falls of the River* Niagara, *taken at* Albany, Octob. 10. 1721. *from Monſieur* Boraſſaw, *a* French *Native of* Canada. *By the Honourable* Paul Dudley, *Eſq;* F. R. S.

THE Falls of *Niagara* are a mighty Ledge or Precipice of ſolid Rock, that lies acroſs the whole breadth of the River (a little before it empties it ſelf into, or forms the Lake *Ontario*) and very ſteep.

Monſieur *Boraſſaw* never meaſur'd the Falls himſelf, though he has been there at ſeven different Times: But what he ſays is, That,

This laſt Spring the Governour of *Canada*, Monſieur *Vaudreil*, ordered his own Son, with three other Officers, *viz.* Meſſieurs *Longue Iſle*, St. *Ville*, and *Laubineau* to Survey *Niagara*, and take the exact height of the Cataract, which they accordingly did with a Stone of half an hundred Weight, and a large Cod-line, and found it upon a Perpendicular no more than twenty ſix Fathom; his Words were *Vingt & Six Bras.*

This differs very much from the Account Father *Hennepin* has given the World of that Cataract, for he makes it an hundred Fathom; and our Modern Maps from him, as I ſuppoſe, mark it at ſix hundred Feet; but I believe *Hennepin* never meaſured it, and there is no gueſſing at ſuch Things.

An

When

When I objected *Hennepin*'s Account of thoſe Falls, to Monſieur *Baraſſaw*, he replied; That accordingly every Body had depended upon it as right until the late Survey. Upon further Diſcourſe he acknowledged, That below the Cataract for a great way, there were numbers of ſmall Ledges, or Stairs croſs the River, that lower'd it ſtill more and more, till you come to a Level; ſo that if all the Deſcents be put together, he does not know but the Difference of the Water above the Falls, and the Level below, may come up to Father *Hennepin*, but the ſtrict and proper Cataract upon a perpendicular, is no more than twenty ſix Fathom, or an hundred and fifty ſix Foot, which yet is a prodigious Thing, and what the World I ſuppoſe cannot parallel, conſidering the greatneſs of the River, for it is near a Quarter of an *Engliſh* Mile broad, and very deep Water.

Several other Things Monſieur *Baraſſaw* ſet me right in, as to the Falls of *Niagara*. Particularly it has been ſaid, That the Cataract makes ſuch a prodigious noiſe, that People can't hear one another ſpeak, at ſome Miles diſtance, whereas he affirms, you may converſe together cloſe by.

I have alſo heard it poſitively aſſerted, That the Shoot of the River, when it comes to the Precipice, was with ſuch a mighty force, that Men and Horſe might march under the Body of the River without being wet. This alſo he utterly denies, and ſays the Water falls in a manner right down.

What he obſerv'd farther to me was,

That the Miſt or Shower (his Word was *La Brume*) which the Falls make, is ſo extraordinary, as to be

ſeen

ſeen at five Leagues diſtance, and riſes as high as the common Clouds. In this Brume or Cloud, when the Sun ſhines, you have always a glorious Rainbow.

Of the River it ſelf, which is there called the River *Niagara*, he tells me it is much narrower at the Falls, than either above or below, and that from below there is no coming nearer the Falls by Water, than about ſix *Engliſh* Miles, the Torrent is ſo rapid, and withal ſuch terrible Whirl-pools.

He confirms Father *Hennepin*'s and Mr. *Kellug*'s Account of the large Trouts of thoſe Lakes, and ſolemnly affirmed there was one taken lately, that weighed eighty ſix Pounds; which I am the rather inclined to believe upon the general Rule that Fiſh are according to their Waters. To confirm which, a very worthy Miniſter, now alive in *New England*, affirmed to me; That while he was a Priſoner at *Mon-real*, in *Canada* River, he ſaw a Pike brought up one Day from the River to the Governour's Houſe, and carried upon a Pole between two Men, that meaſured Five Foot, and Ten Inches long, and proportionably large.

I my ſelf this laſt Summer, ſaw a Cataract, three Leagues above *Albany*, in the Province of *New York*, upon *Schenectada* River called the *Cohoes*, which they count much of there; and yet that is not above 40 or 50 Foot perpendicular. From theſe Falls alſo there riſes a miſty Cloud, which deſcends like ſmall Rain, that, when the Sun ſhines, gives a handſome ſmall Rainbow that moves as you move, according to the Angle of Viſion. The River at the *Cohoes* is to 40 or 50 Rods broad, but then it is very ſhallow Water, for I was told that in a dry Time, the whole River runs in a Channel of not more than fifteen Foot wide.

In my Journey to *Albany*, 20 Miles to the Eaſtward of *Hudſon*'s River, near the middle of a long riſing Hill, I met with a brisk noiſy Brook ſufficient to ſerve a Water-Mill, and having obſerved nothing of it at the beginning of the Hill, I turned about and followed the Courſe of the Brook, till at length I found it come to an End, being Abſorb'd, and ſinking into the Ground, either paſſing through Subterraneous Paſſages, or ſoaked up with the Sand; and tho' it be common in other Parts of the World for Brooks and even Rivers thus to be loſt; yet this is the firſt of the Sort, I have heard of, or met with in this Country.

P. Dudley.

IV. *A Letter from Mr.* Leeuwenhoeck, *F. R. S. concerning the Muſcular Fibres in ſeveral Animals, and the Magnetick Quality acquired by Iron, upon ſtanding for a long time in the ſame Poſture.*

Delft, *Apr.* 21ſt, 1722.

To the Illuſtrious Royal Society.

Honoured Sirs,

IN a Letter I receiv'd ſometime ago from one of your Secretaries, among many Expreſſions of your kind Acceptance of my Labours, I am requeſted by that Gentle-

Gentleman in the Name of the *Royal Society*, to endeavour by repeated Obſervations to confirm ſome of my late Diſcoveries, and to ſet them in ſo clear a Light, as to ſtop the Mouths of the moſt incredulous Gainſayers.

With regard to this, I beg leave to obſerve to you, that I examine a great many different Subjects, of which I commit no account to Paper, becauſe the Reſult is the ſame with what I have already deſcribed; and that whenever I make any Diſcovery, which I apprehend will not eaſily meet with Credit, I ſuffer the Object to lie before the Microſcope Day after Day, and ſometimes for whole Years together, till it is eaten up by Inſects. This I do with deſign to let it be ſeen by as many different Perſons as poſſible.

It is not above eight Days ago, that I was viewing a Portion of the Fleſh of a fat Ox, as likewiſe the Muſcular Fibres of a Cod-Fiſh, and of a Pearch, which Fibres being cut tranſverſly, I could ſee in them very diſtinctly the great number of ſmall Veſſels, that ran along the length of each Fibre. And I have ſeen the ſame this Month of *April*, in the Muſcular Fibres taken from the hinder Leg of a Mouſe, and cut thro' tranſverſly.

I have at this time ſtanding before a Microſcope, ſome of the Muſcular Fibres of a fat Ox with thoſe of a Mouſe lying beſide them, in order to have as many Eye-witneſſes as poſſible, of their being of the ſame ſize in theſe two Animals, and I uſe the ſame Method in ſuch other of my Obſervations, as are likely to appear incredible to other Perſons.

In ſpeaking formerly of the ſmall *Fibrillæ*, that help to ſuſpend the Teſticles of a Ram, I forgot to mention, that each of theſe conſiſts of exceeding ſmall Veſſels, which run parallel to its length.

I have likewiſe at this time ſtanding before a Microſcope, a ſmall Portion of the Bone of an Ox, in which may evidently be ſeen the Veſſels, which proceed from the Bone, and compoſe what is called the *Periosteum*, as likewiſe the Openings of theſe Veſſels; the reaſon of whoſe appearing ſo clearly is, as I imagine, that they are filled with the Medullary Oil.

I take this Opportunity of informing you, that the Iron Croſs, which is ſuppoſed to have ſtood upon the Steeple of the New-Church here about two hundred Years, having been lately taken down to be repair'd, I was inform'd by a certain Foreign Gentleman, that a piece of Iron, that has ſtood for a long time in one Situation, would thereby acquire a Magnetick Quality. Upon which I deſir'd a Workman to procure me a piece of that Croſs, who accordingly brought me a bit of it, of about a Span long, and a quarter of an Inch thick, which I apply'd both to a working Needle, and the Needle of the Compaſs, but without any Effect upon one or the other.

Some time after, the ſame Workman brought me ſome other pieces, looking like ruſty Iron, which he had broken off from the bottom of the Croſs, where it had been faſten'd by four croſs pieces bound down with Iron, to an erect piece of Timber nine Inches ſquare, and cover'd with Lead in ſuch a manner, that no wet could get to it.

This ſeeming ruſty Iron would take up ſeveral Needles hanging by one another, and appear'd to have a ſtronger Magnetick Virtue than two Loadſtones, which I had then in the Houſe; and was ſo hard, that no File would touch it. I gave one of the greateſt pieces to a Knifegrinder, to grind it for me, who was a long time about it, and complain'd that it was harder than Steel.

The

The Report of this made ſo great a Noiſe in the Town, that in a little time my pieces of Iron were all begg'd away, except one little one, which I kept for my ſelf.

I am, &c.

Antony van Leuwenhoek.

V. *An Account of the manner of bending Planks in His Majeſty's Yards at* Deptford, *&c. by a Sand-heat, invented by Captain* Cumberland. *By* Robert Cay, *Eſq;*

THE place, where the Planks lie to be ſoftned in the Stove, is between two Brick-Walls; of ſuch a length, height and diſtance from each other, as ſuffice to admit the largeſt, or to hold a good number of the ſmaller Sort: the bottom is of thick Iron Plates, ſupported by ſtrong Bars; under the middle of which, are two Fire-places, whoſe Flews carry the Flame towards the Ends.

The Planks are laid in Sand; the loweſt about ſix or eight Inches above the Iron-Plates, they are well cover'd with the Sand, and Boards laid over all, to keep in the Heat. The Sand is moiſtned with warm Water, (for which purpoſe they have a Cauldron adjoyning to the Stove) and if the Timber be large, and intended to be very much bent, ſo that it muſt lie

long in the Stove, they water the Sand again, once in 8 or 10 Hours. When 'tis judged to be ſoft enough, the Sand is remov'd; and the Workmen carry away their reſpective Planks, to the ſeveral Places, where they are to be us'd; and having firſt nail'd a thin Board upon the out-ſide, to preſerve the Plank from Bruiſes, they fix one part in its proper place, and bring to the others, by any power they can moſt conveniently apply. This Work ſeems to be perform'd with wonderful Eaſe; notwithſtanding ſome we ſaw were ſo knotty, that the Builders aſſur'd us, they cou'd not have brought them to that Curvature by the former Methods. Thoſe we ſaw put in between others, very exactly fitted the Spaces they had been cut for; and the Workmen told us, they had made no Allowance either for the ſwelling, or ſhrinking of the Wood.

This Method excells that of burning the Planks over an open Fire in ſeveral reſpects: particularly, that no part of the Wood is deſtroy'd, but remains of the ſame Dimenſions; at leaſt very nearly; a Plank of the breadth of 16 Inches being ſaid not to alter above $\frac{1}{20}$ part of an Inch. The Edges of the Plank are preſerv'd; and conſequently the Work muſt be much firmer, and the Calking laſt longer. The extraordinary ſoftneſs of the Wood, while 'tis warm, makes it eaſily bend to any Figure neceſſary in Ship-building, which it holds very well, if they have occaſion to take it off again after it is cold: whereas the Plank bent by burning, would ſtart when looſened; and could only be fixed to the Timbers by ſuch a force, as was able to overcome the Reſiſtance occaſion'd by the Spring of the Plank. It likewiſe adapts it ſelf very readily to the Surface of the Timbers, if they happen to be uneven.

They

They ſhew'd us the Gun-Deck-Clamps in a Ship of the Second Rate; which are very large Planks, bent and twiſted in ſo peculiar a manner, that they never could by any other Method, bend them into that Form, but uſed to cut them into Shape. The whole Operation is perform'd with much leſs trouble to the Carpenters, as well as at leſs Expence; and they hope the Wood will be more durable; as 'tis evident, from the deep Tincture the Sand receives, that a conſiderable quantity of Sap comes out of the Oak, while its in the Stove: and a large Plank was obſerv'd by the Workmen or Officers of the Yard, to weigh ſome Pounds leſs, when it was taken out.

A Plank five Inches thick requires five or ſix Hours to make it fit for bending; and the Time requiſite for others, ſeems to be in a Duplicate Propottion to their thickneſs.

Explanation of the Figures.

Fig. 1. Repreſents a Plank, in the Buttocks of a Second Rate Ship, whoſe length from *A*, to *C*. is three Feet, and thickneſs (*AF*) $4\frac{1}{4}$ Inches, the end *C*, of this Plank was bent 12 or 13 Inches from the ſtreight Line *AB*

Fig. 2. and 3. are Sections of the Stove.

A A the Fire-places.

B. B. the Aſh-holes.

C. C. the Flews under the Iron bottom.

D. D. the two Chimneys.

E. the place for the Planks and Sand.

F. F. the two Brick-walls.

G. G. two inclin'd planes, for the Men to ſtand on, *&c.* when they put in, or take out Planks, or water the Sand.

h. h. The bottom of the Stove, made of Iron.

i. i. The Grates to lay the Fewel on.

VI. *A Letter from the Reverend Mr.* James Field, *Rector of* St. Johns *in* Antegoa, *concerning two Caſes of Wounds in the Stomach, to Mr.* John Douglas, *Surgeon,* F. R. S.

SIR,

THE Accidents of which you deſire me to give you an account, were as follows.

A luſty young Negro man returning home about Noon, went into his Houſe, where ſeeing ſome ripe Plantains, he eat of them heartily; his Father in Law, about 60 Years of age, coming to the ſame Houſe ſoon after, enquired of the young Fellow, who had taken his Plantains. Who anſwered, That he being hungry, had eaten them. Ay, you Dog, ſays the old Fellow, have you ſerved me ſo, I kept them for my own Dinner; and without more ado, took his Knife, and gave the young Fellow a moſt deſperate Wound in the upper Region of the Belly, a vaſt Gaſh being made in the Stomach, in ſo much that the Plantains which he had eaten, burſt through the Wound, which was made ſtreight up and down.

The

The old Man immediately fled for it, the young Fellow's Companions hearing what was done, purſued the old Man with Bills in their Hands: the old Man, ſeeing them follow him in this manner, and get ground of him, and ſuſpecting their Deſign was to kill him, pull'd out the ſame Knife, with which he had ſtabb'd the other, and gave himſelf as deſperate a Wound, as he had given him, and in the upper Region of the Belly, his Stomach being likewiſe ſeen, only with this Difference, that this laſt Wound was tranſverſe, or from left to right, the firſt directly up and down; the old Fellow was carried home and laid in the ſame Houſe, where the other wounded Fellow lay.

This Accident happen'd about Noon, and Mr. *Forreſt*, the Surgeon came not to dreſs them till between four and five; he ſtitch'd up the Stomachs of them both entirely, and their Bellies too, only leaving in each a ſmall hole for Suppuration; a Fever ſeized each of them, the old Man was in moſt danger, the Fever held them about a Fortnight, the Wounds were brought to a good Digeſtion, and in a Months time or thereabouts, the young Fellow went abroad, but the old Man lay ſomething longer. They were both perfectly cured, and have been very well ever ſince, tho' its above fifteen Years ſince this Accident happen'd.

Windſor,
Aug. 24. 1720.

I am, &c.

Jam. Field.

VII. *A Letter from Mr.* Atkinſon, *Surgeon in* White-Chappel: *Concerning an Impoſthumation in the Stomach. To the ſame.*

SIR,

THE Caſe you deſire a particular account of, was as follows. I had a Patient about ſeven Years ago, which had a large Tumour on the upper part of her Belly, it was hard and painful, but did not alter the natural colour of the Skin, and had been three Months in coming. I applied a warm Gum Plaiſter to it, which in about a Fortnights time brought it to a Suppuration. I then applied a Cauſtick about the bigneſs of a Shilling; when the Eſchar fell off, I ſaw a ſolid kind of Subſtance appear in the Orifice, I laid hold of it with my *Forceps*, and pulled it gently towards me, upon which there thruſt forcibly out a quantity of it, that near fill'd my Hand, ſo I dreſt it. Next dreſſing, the ſame Subſtance appear'd again, which on her ſtraining, forced out near twice as much as before. I was at a great loſs to determine what this ſtuff was, but at laſt concluded it was the *Omentum* it ſelf, in which Opinion I was confirm'd by ſome other Surgeons I ſhew'd it to. I was ſtill in doubt, whether the Stomach was concerned in this Caſe or not, till the next Removal of the Dreſſings, at which there ſpurted out above half a Pint of Ale in a full Stream, which was part of a Pint ſhe had drunk a little while before. I now concluded the Caſe mortal, however, I ordered her to keep her Bed, to lie conſtantly upon her Back, and feed on things of eaſie Digeſtion.

Digeſtion. The greateſt part of what ſhe eat or drank, came through the Ulcer for eight or ten Days, ſo that I had no hopes of ever curing it, yet contrary to my Expectation in about ſix Weeks ſhe was perfectly cured, and is now living and in good Health.

VIII. *An Account of the quantity of Reſin in the* Cortex Eleutheriæ. *By Mr.* John Brown, *Chymiſt*, F. R. S.

DR. *Douglas* having lately deliver'd in a Paper to be read before this Society, giving an account (from the Hiſtory of the Royal Academy at *Paris*) of the *Cortex Eleutheriæ*; and among other things having ſaid of it, that Monſieur *Boulduc* had from one Ounce of the Bark, by means of Spirit of Wine, gotten 5 Drachms of Reſinous Extract, there remaining 3 Drachms of *Fæces*; and that Gentleman's account of ſome of the Properties of this Bark being founded on the quantity of Reſin ſuppos'd to be contain'd in it: I propos'd to Dr. *Douglas* and ſome other Gentlemen of the Society, (who agreed with me in believing, that ſcarcely any part of any Plant whatſoever would yield that quantity of Reſinous Extract) to try the Experiment, which was perform'd after the following manner.

I took two Ounces of pick'd Bark, and digeſted it in rectify'd Spirit of Wine, which was often decanted and freſh Spirit put on, until the Bark would yield no more Tincture. The impregnated Spirit being evaporated by a very gentle heat; there was left two Drachms of Reſinous Extract; the remains of

the Bark dry'd, weigh'd one Ounce, two Drachms and a half; the loſs this way is three Drachms and an half

I boil'd theſe remains in ſeveral Waters, until they would no longer tinge the Water, which being evaporated yielded one Drachm and an half of extract; the remains of this dry'd weigh'd one Ounce and half a Drachm; the loſs by this Method is half a Drachm.

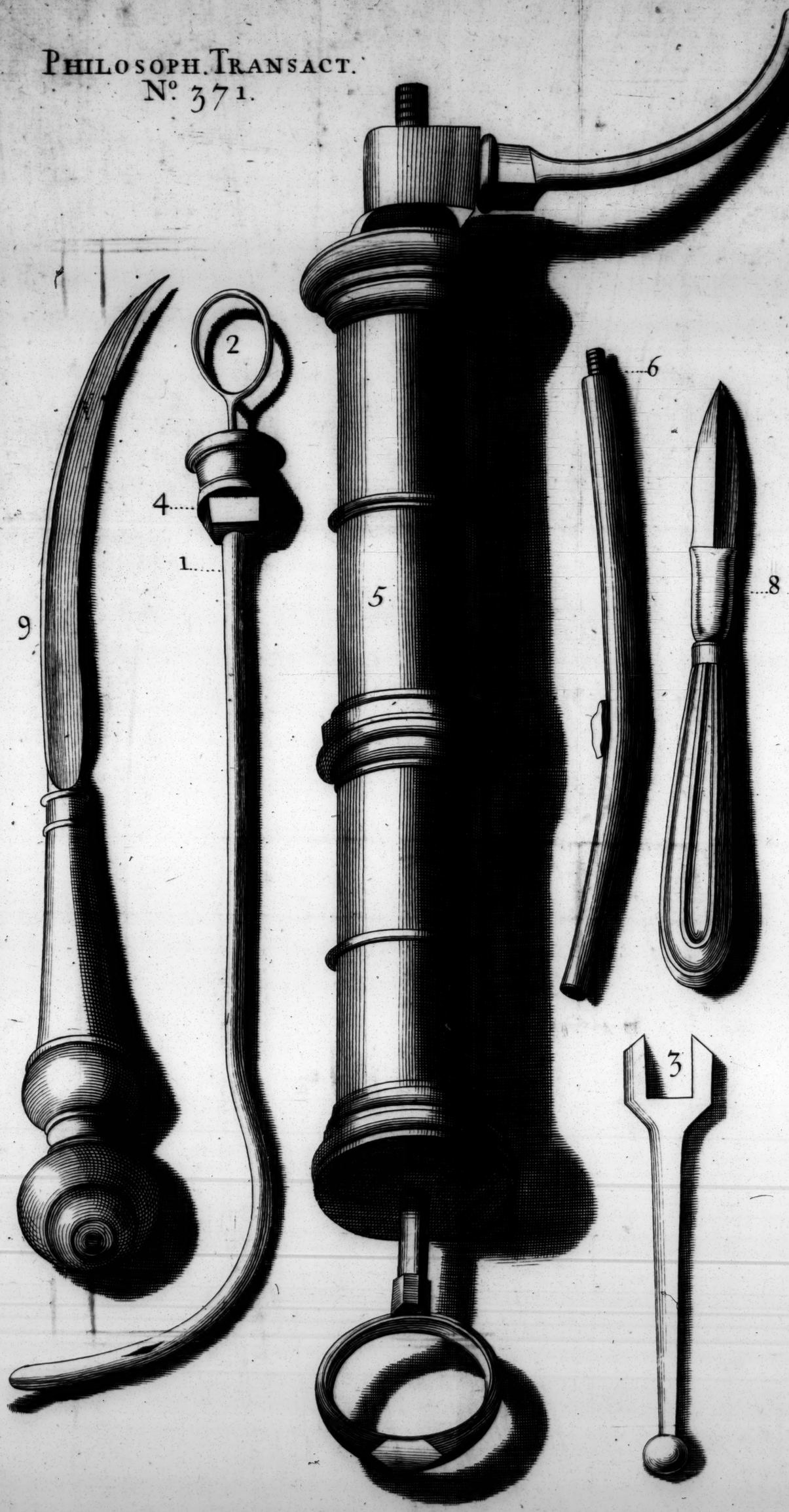
I took two Ounces more of pick'd Bark, and boil'd it in ſeveral Waters, 'till the Bark gave no more Colour; and then upon an Evaporation of the Water, had two Drachms of Extract. The remains being dry'd weigh'd one Ounce ſix Drachms; here the loſs was not any thing, except ſo much as might anſwer in weight to the quantity of the *Menſtruum* left in the Extract, which Allowance muſt likewiſe be made in the other Extracts.

I digeſted the remains in rectify'd Spirits of Wine, untill they no longer ting'd the Spirit, and by a very gentle Evaporation, I found remaining one Drachm of Reſinous extract. What was left, when dry'd, weigh'd one Ounce, two Drachms, and an half; in this the loſs was two Drachms and an half.

The Difference in the quantity of Extract obtain'd by theſe two different Methods, is but half a Drachm, and the Medium between them, upon putting together the ſeveral Extracts made with Spirit of Wine and Water, is in the whole but three Drachms and a quarter. But the Extract made with Spirit of Wine alone, is no more than two Drachms from two Ounces of the *Cortex*, inſtead of ten Drachms, which it ought to have yielded according to Monſieur *Boulduc*.

IX. *An*

PHILOSOPH. TRANSACT.
Nº 371.



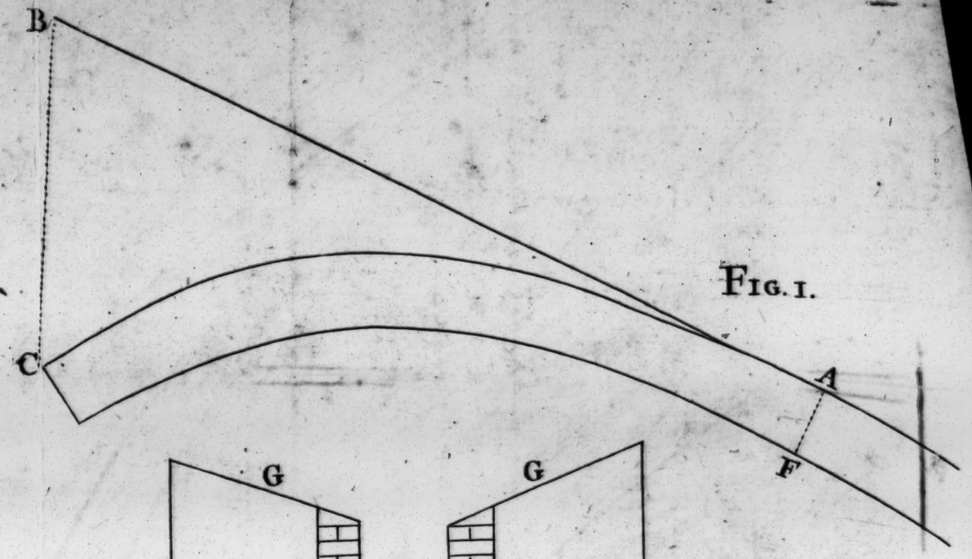


FIG. I.

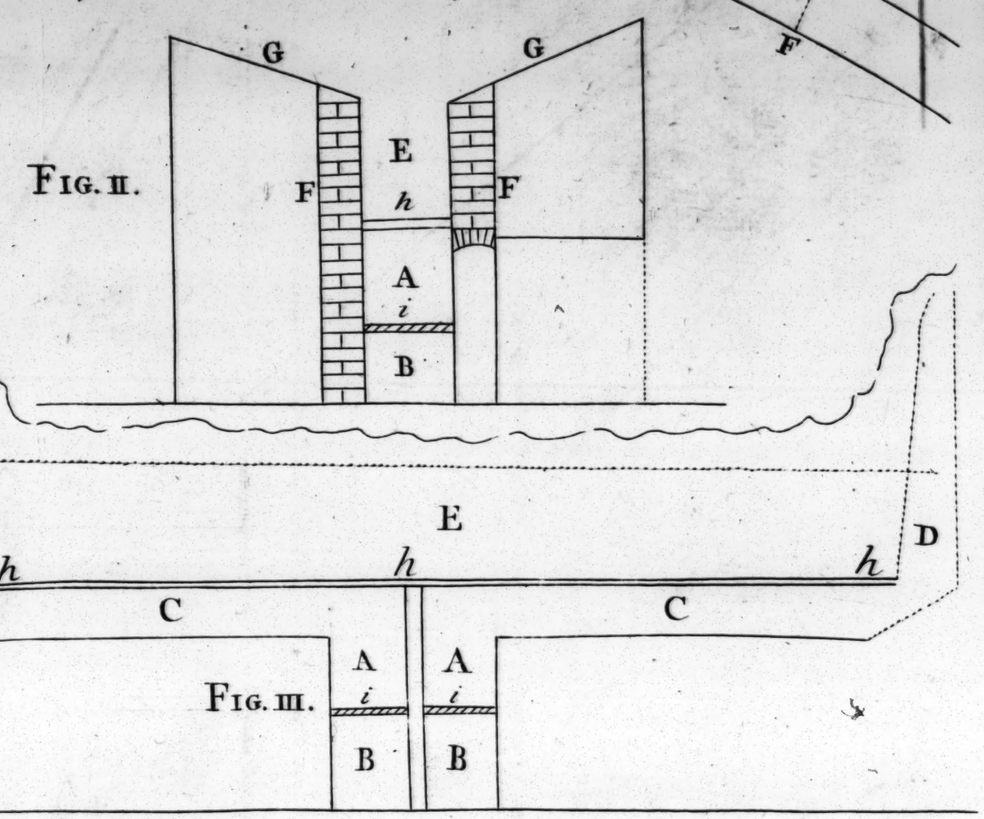


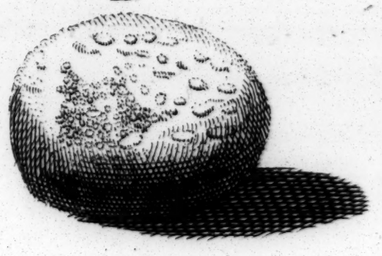
FIG. II.

FIG. III.

10.

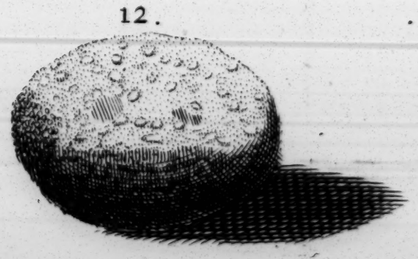


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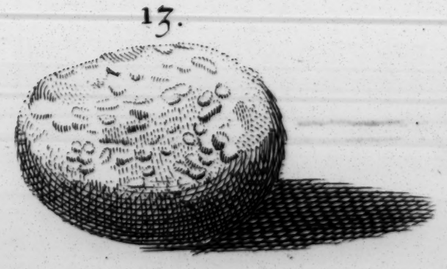


The natural Figure and Bigneſs of ye Stones.

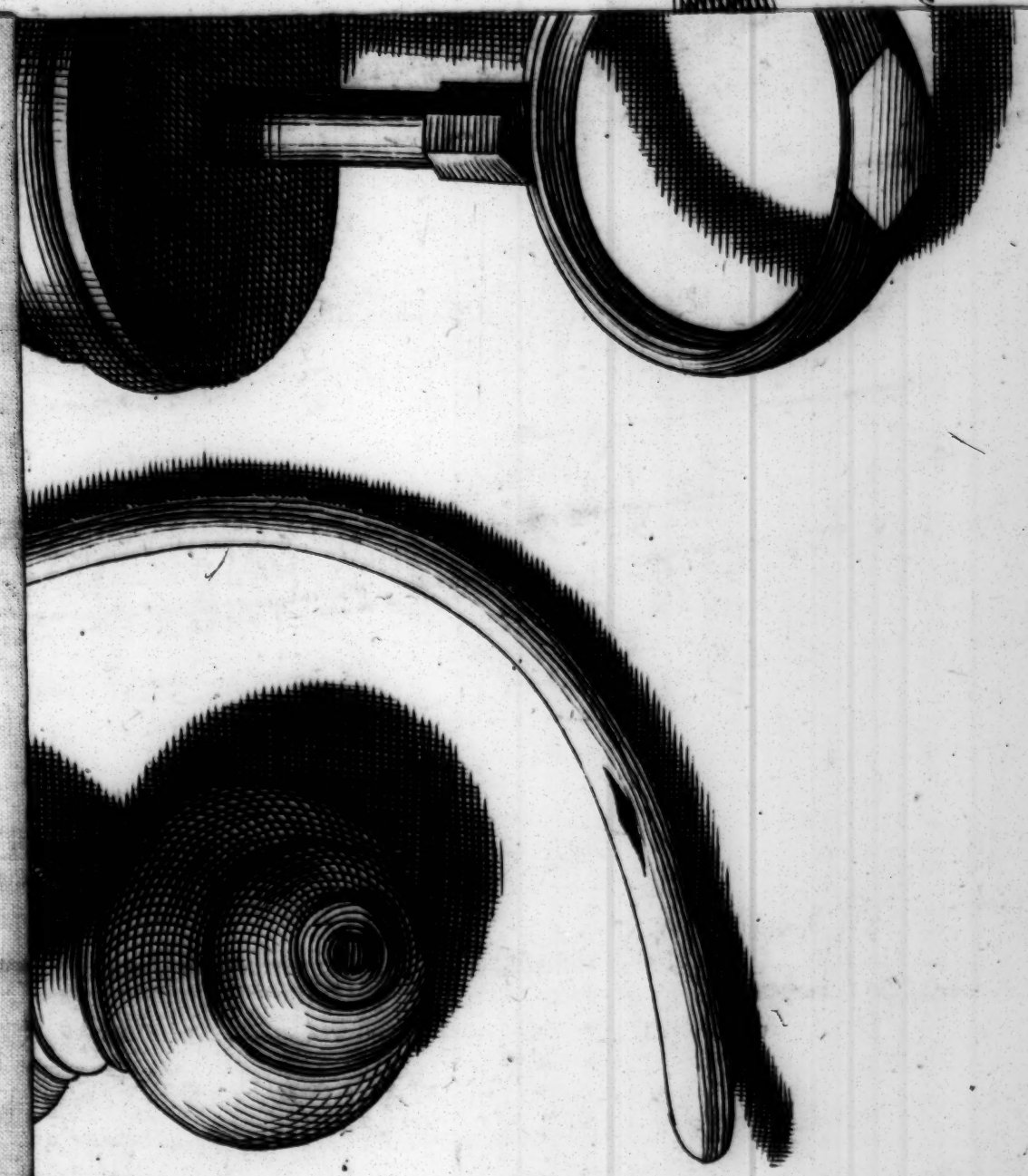
12.



13.



Sturt sc.



IX. *An Account of the new Method of Cutting for the Stone.* By J. Douglas, *Surgeon*, F. R. S.

EVer ſince I was Anatomiſt and Surgeon enough, to reaſon upon the Cauſes of the Tedioufneſs and bad Succeſs of the common Methods of Cutting for the Stone, I concluded that they were principally owing to the natural Structure and Situation of the Parts concern'd.

Therefore I began to conſider, why that Operation might not be perform'd the high way, ſo frequently mention'd by Authors, but never approv'd of by any, except the moſt ſagacious of all Surgeons, *Fr. Roſſetus*, who has certainly been very little read, or elſe very ill underſtood, elſe this Operation had not been ſo long a Secret.

After making ſome Experiments on dead Bodies, I was convinced, that the Stone might be extracted that way with a great deal of leſs trouble than commonly, and I was perſwaded that the Wound would heal again, by the great number of authentick Inſtances we have of accidental Wounds in the ſame place being ſpeedily and firmly cured; and therefore I reſolv'd to make the Experiment on the firſt Patient I could meet with, which I could not procure till *December* 1719. and then I proceeded as follows.

The Patient was plac'd flat on his Back, on a Table, with a Pillow under his Head; then his Wriſts and Ancles were faſten'd together, with Straps Then

I ordered one Aſſiſtant to his Head, another to each of his Shoulders, two to the *Penis*, one of which was to manage the Ligature, and the other the Prepuce, and one to each Knee, to hold them as faſt and firm as poſſible.

The Patient and Aſſiſtants being thus plac'd, the Operation conſiſts of three Parts.

1*ſt*, In filling the Bladder, which is done thus:

Firſt, Paſs the *Catheter*, Fig. 1. then draw out the Stillet, Fig. ii. then order the Ligature Aſſiſtant to caſt the Ligature, with is a Skein of Silk, round the *Penis*, above the Glans. Then fix the Key, Fig. iii. to the head of the *Catheter*, Fig. iv. to keep it ſteady, while you ſcrew on the Syringe, Fig. v. then ſcrew the ſecond part of the Sucking-Pipe, Fig. vi. to the firſt, Fig. vii. Then order the *Penis* Ligature to be ſtraiten'd, and the Prepuce Aſſiſtant to gather the Prepuce up about the *Catheter*, and to hold it as cloſe as poſſible. Then order the Water, being a little warmer than Milk, to be clapp'd under the Sucking-Pipe, then draw up the Water into the Syringe, and thruſt it into the Bladder at leiſure, and repeat it till the Bladder is ſo full, that you can perceive its Tumour through the *Abdomen*, (at which time you will alſo obſerve the *Penis* above, and the Prepuce below the Ligature, very much ſwell'd, and the Patient in a great deal of Pain) which is a certain Sign that there is enough injected; then withdraw your Syringe and *Catheter* together, taking particular care that your *Penis* Aſſiſtants ſtraiten their gripe, leaſt the Water ſhould follow the *Catheter*, which would undo all.

2*dly*, In making the Inciſion, which is done thus:

Order the *Penis* Aſſiſtants to turn the *Penis* towards the *Anus*, that ſo their Hands may be the more out of the way, then take the firſt Knife, Fig. viii. and cut at leiſure, and with a ſteady Hand, from

near

near the upper part of the Tumour of the Bladder, or lower, according to the computed bigneſs of the Stone, down to the *Os Pubis*, and exactly in the middle; when you are got a little more than half way through the abdominal Muſcles, take the ſecond Knife, Fig. ix. clap its back on the middle of the *Os Pubis*, then run its point down towards the *Sphincter*, until you get into the Cavity of the Bladder, which is diſcover'd by the iſſuing out of the Water, then run your Knife along very quickly towards the Fund of the Bladder, as far as is neceſſary.

3*dly*, In extracting the Stone, which is done thus: Before you withdraw your Knife, introduce the fore and middle Fingers of your left hand, between the Knife and the *Os Pubis*, into the Bladder, then withdraw your Knife, and thruſt the fore and middle Fingers of your right hand into the *Anus*, and raiſe the Stone up towards the Wound, and ſo you will eaſily catch hold of it, (though never ſo ſmall) with your Fingers which are in the Bladder, then draw it out with the ſmalleſt end foremoſt. Then introduce your Fingers again, to ſee if there are any more Stones, which are to be drawn out as before.

Then take a Needle and Thread, and make one Stitch through the Skin, in the middle of the Wound, and tie it pretty cloſe, then undo the Straps and carry the Patient to Bed.

The Patient being put to Bed, I laid a Pledget arm'd with Balſam over the Wound, and a bit of ſticking Plaiſter over that. Then I embrocated all the *Abdomen*, *Scrotum* and *Penis*, with warm *Ol. Chamæmel.*; then I applied over the dreſſing and all the *Abdomen* an *Emollient Pultice*, ſpread almoſt an Inch thick on ſoft Flannel; then I turn'd a ſwath a little broader than the Patient's Hand once round him,

and

and pinn'd it on the Pultice Cloath, juſt tight enough to keep it on.

As ſoon as he was dreſs'd, I gave him an Opiate (for nothing is ſo proper as reſt) ſuch as this ℞ *Aq. Cinnam. Hord.* ℥ii. *Laud. Liq. Gutt.* xv. *Syr. de Mecon.* ℥ii. which may be encreaſed or diminiſhed as the Caſe requires.

Next Evening I took off the Pultice and dreſſing, and cut the Stitch; then fomented the Wound and all the *Abdomen* with Stupes wrung out of *Aq. Calc.* and freſh Urine, as warm as he could bear it; then dreſs'd the Wound as before. Then I rubb'd all the *Scrotum*, *Penis*, and Groins with *Unguentum Album*, to prevent their being ſcalded by the Urine, which flows from the Wound.

The Wound muſt be dreſs'd twice a Day at leaſt, till you have a plentiful Digeſtion.

After every dreſſing, the Ointment and Oil was uſed, as before directed.

There is little Variation in the dreſſing of the Wound, except what is common in others.

The Urine flows always through the Wound, until the Wound of the Bladder is cured, which is ſooner or later according to the Conſtitution of the Patient.

When the Urine begins to come the right way, it pains and ſcalds them much after the ſame manner, as when they had the Stone, (which is cauſed by the Contraction of the *Urethra*, that has been ſo long uſeleſs,) but it never laſts above a Day or two, and then they make Water with the ſame Eaſe and Freedom, as any other Perſon.

They ought not to be forced to go to Stool under ſix or ſeven Days, unleſs there is ſome particular reaſon for it, becauſe ſtraining to go to Stool injures the Wound.

They

They ought never to be taken up, except to get their Beds made, until the Urine comes all the right way, becauſe it makes them ſick and faint; and conſequently hinders the Cure of the Wound.

Cold is to be avoided as the Peſt, becauſe it puts them to a great deal of pain either to ſtifle it, or to Cough out.

N. B. If a flexible *Catheter* could be paſs'd, and kept in the Paſſage without pain, it would very much haſten the Cure of the Wound.

I made this Operation the firſt time on the 23d of *December* 1719. upon a Boy between 16 and 17 Years of age, and in five Weeks time he was perfectly cured.

The Stone was of the Figure and Bigneſs of *Fig.* x.

I made the ſecond Operation on the 12th of *May* 1720. on a Boy of Eight Years of age, and in ſix Weeks time he was perfectly cur'd.

The Stone was of the Figure and Bigneſs of *Fig.* xi.

The third Patient was but three Years of age, and was Cut in *Auguſt* 1720. but died of Convulſions about 15 Hours after the Operation.

Fig. xii. Shews the Form and Bigneſs of this Stone.

The fourth Operation was made on the 23d of *March* 1720-21. upon a Boy about 14 Years of age, and in four Weeks afterwards he was perfectly cured.

This Stone is repreſented in *Fig.* xiii.

In this Patient I made a ſmall Wound in the *Peritonæum*, through which I ſaw the Guts preſent, but I puſh'd them back with my Finger, and then ſtitch'd the Skin, and we had no farther Inconveniency by it. Theſe three Patients have been already ſhew'd before this Society.

This

This Operation may be perform'd with equal Succeſs on Females, when the Stone is large, but if it is but ſmall, the common way of extracting them is very good.

From all which I think I may ſafely conclude in the Words of the inimitable *Roſſetus*.

Poſt hæc nemini dubium eſſe debet, novam hanc noſtram Cyſtotomiam, vetere illâ tot doctiſſimorum Chirurgorum Cyſtotomiâ (tam periculosâ, ut eam aggredi vel ipſe Hippocrates Chirurgôn Chirurgotatos metuerit) & leniorem & tutiorem haberi.

FINIS.

LONDON:

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Jos: Banks

Numb. 372.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *June*, *July*, and *August*. 1722.

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II. *A Letter to the* Royal Society *concerning the Particles of Fat. By Mr.* Leeuwenhoek, *F.R.S. Tranſlated from the* Dutch *by* John Chamberlayne, *Eſq*;

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VIII. *An Account of a Book, intituled,* Harmonia Menſurarum, ſive Analyſis & Syntheſis per Rationum & Angulorum menſuras promotæ : accedunt alia Opuſcula Mathematica : per *Rogerum Coteſium.* Edidit & auxit *Robertus Smith,* Coll. Trin. Cantab. & Reg. Soc.

Soc. Socius; Aſtronomiæ & Experimentalis Philoſoph. poſt *Coteſium* Profeſſor. *Cantabrigiæ* 1722. in 4to. Proſtant apud Bibliopolas Londinenſes.

ERRATA.

Pag. 111. *lin.* 13, *pro* = *leg.* proportionalem.
Pag. 114. *lin.* 15, *dele* '.

Pag. 123. *lin.* 13, *leg.* $\sqrt{aa+RR}+R$.

Pag, 127. *lin.* 3, *dele brevem lineam, quæ ſuper* $+b$ *ducitur.*

Pag. 129. *lin.* 15, *leg.* $q\,\varphi\,v$.

*Pag.*130. *lin. ult. poſt* invenietur *adde* ſi modo *m* ſit numerus affirmativus; vel etiam ſi *n* ſit unitas, *m* numerus affirmativus, & 2 *p* numerus impar negativus numero *m* major.

Pag. 132. *lin.* 12, *poſt* requiritur *adde* cujus ſegmenti centrum æqualiter diſtet a lineis A B, C D.

Pag. 138. *lin.* 19, *leg.* ΙΓS.

I. *An Account of a* Parhelion *ſeen in* Ireland. *In two Letters from* Arthur Dobbs *Eſq; of* Caſtle Dobbs *in the County of* Antrim, *to his Brother Mr.* Richard Dobbs *of* Trinity-College *in* Dublin; *and by this laſt communicated to the Royal Society.*

I Saw a pretty diſtinguiſhable *Parhelion* here on *Thurſday* Evening, of which I ſend you the Account below, as I minuted it down after I came Home, having been in the Fields when I ſaw it.

March 22d 172½, about half an Hour after 5 in the Afternoon nearly, I ſaw a diſtinguiſhable *Parhelion*, the Sun near *Weſt*, about an Hour high, the Wind and Carry of the Clouds, about N. and by E. the Sky in ſeveral Places obſcured with light Clouds, and the Sun entring into one ſomewhat more watery, yet ſo as to diſtinguiſh its Disk, At firſt appeared below the Sun, breaking out of the Cloud, ſuch Rays as are uſually ſeen in an Evening, in a Sky interſperſed with Clouds. In a little Time appear'd at the ſame Height with the Sun, as near as I could gueſs, having no Inſtrument, a luminous Spot, being about four Times the largeneſs of the Sun's Disk, and about 30 D. diſtant from the Sun to the Southward, which was covered with the lively Shades of red and yellow on the Side next the Sun, and encreaſed in Splendor (ſo as ſcarce to be born by the naked Eye) till it exceeded the Brightneſs of the Sun, which was then under a thin Cloud, ſo as eaſily to perceive his Disk. After this had appeared about 3 or 4 Minutes, I finding it to be a real *Parhelion*, began to look about for the *Halo* they generally appear in; and as I obſerved

ſome

ſome Rays reſembling a Glory to point upwards from the Sun, I ſaw in thoſe Rays at the ſame Diſtance (being, as near as I could gueſs, about 30 D. perpendicularly above the Sun) the Colours of the *Halo* appearing as in the luminous Spot; but inſtead of finding it, as I expected, in a Circle ſurrounding the ſun, it was inverted, yet not circular, but making an obtuſe Angle, the point towards the Sun. I then looked to the Northward of the Sun, and as the Cloud, which was thicker on that ſide, moved Southwardly, a luminous Spot began to appear at the ſame Diſtance from the Sun as the other, and in the ſame Parallel of Altitude, which had the ſame Colours towards the Sun, and increaſed in Brightneſs, but did not come up to the Brightneſs of the other Spot, yet was as luminous as the Sun then appear'd: this Spot was very little bigger than the Sun's Disk. As the Cloud mov'd on, till it came to about 60 D. to the Southward of the Sun, and 30 D. from the Spot, at an equal Height there appeared another Spot tinged with the Colours of the Rainbow. The whole Appearance laſted a Quarter of an Hour. The Reaſon of my not ſeeing the *Halo's*, which generally appear with them, was, that there was a good deal of clear Sky above the Sun, and the Cloud was too thick below it.

Caſtle Dobbs,
March the 24th 172½.

Arthur Dobbs.

Fig. 1.

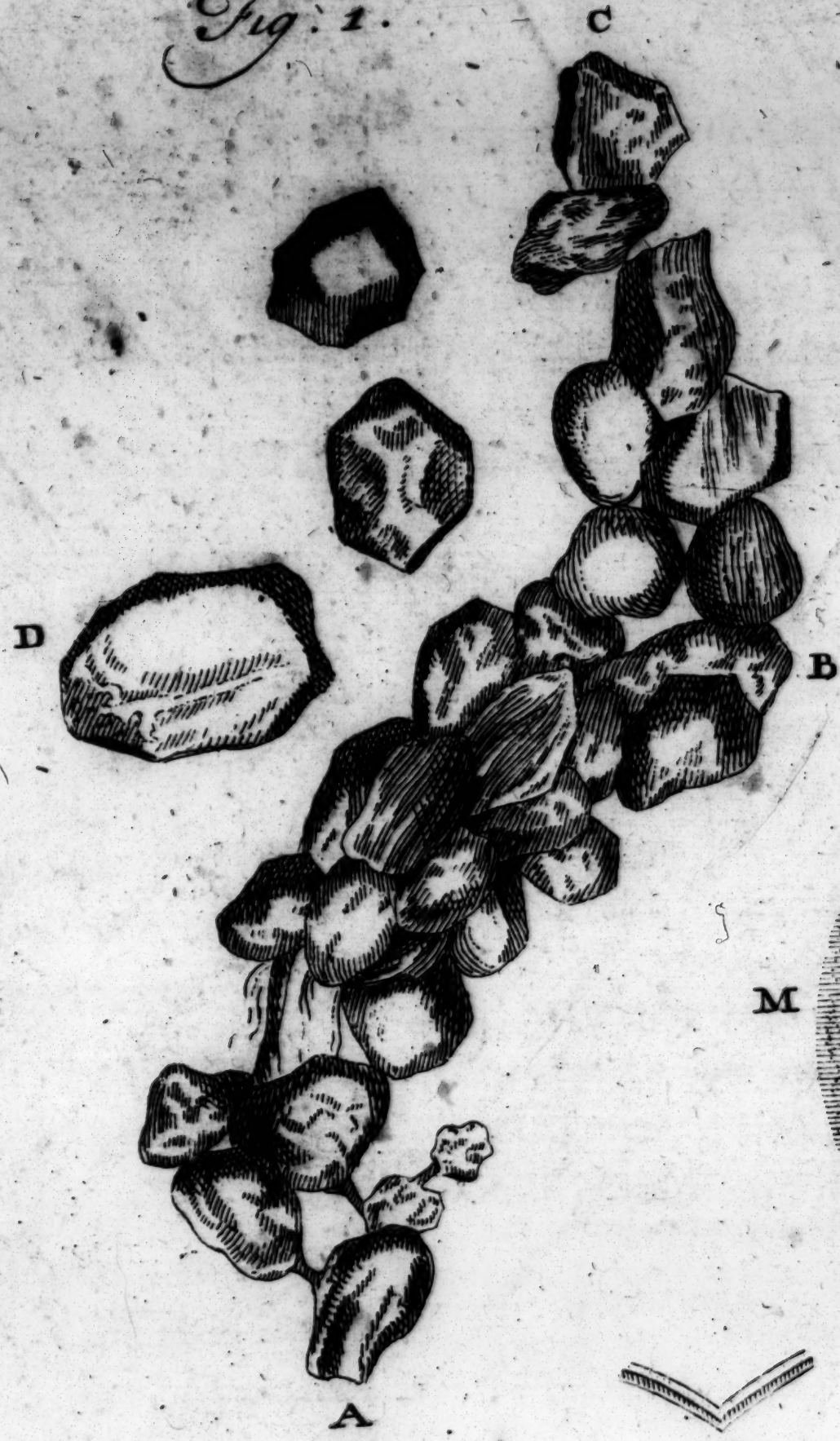
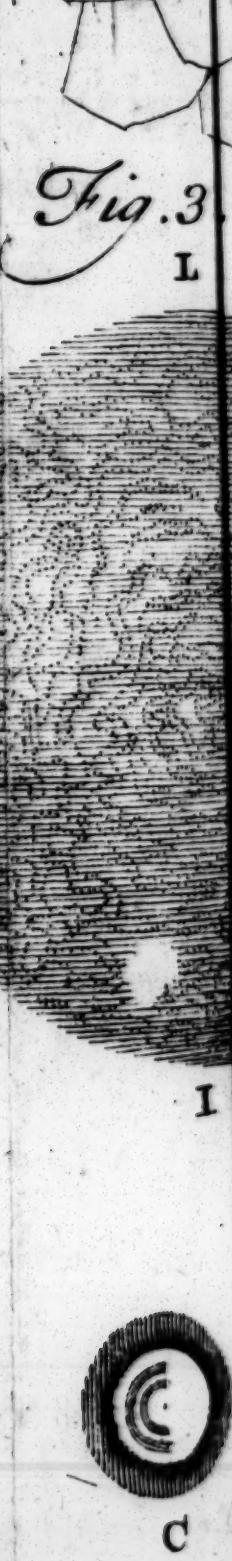


Fig. 3.



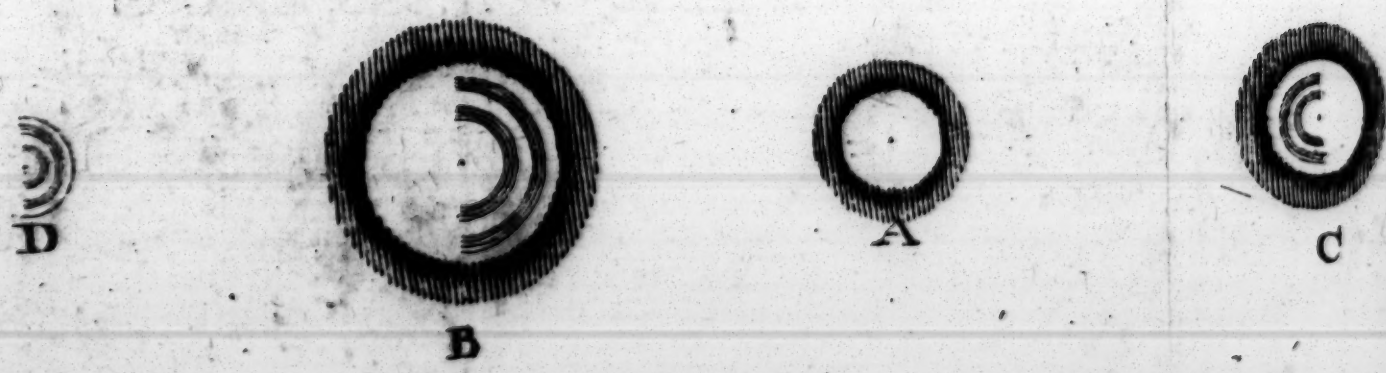
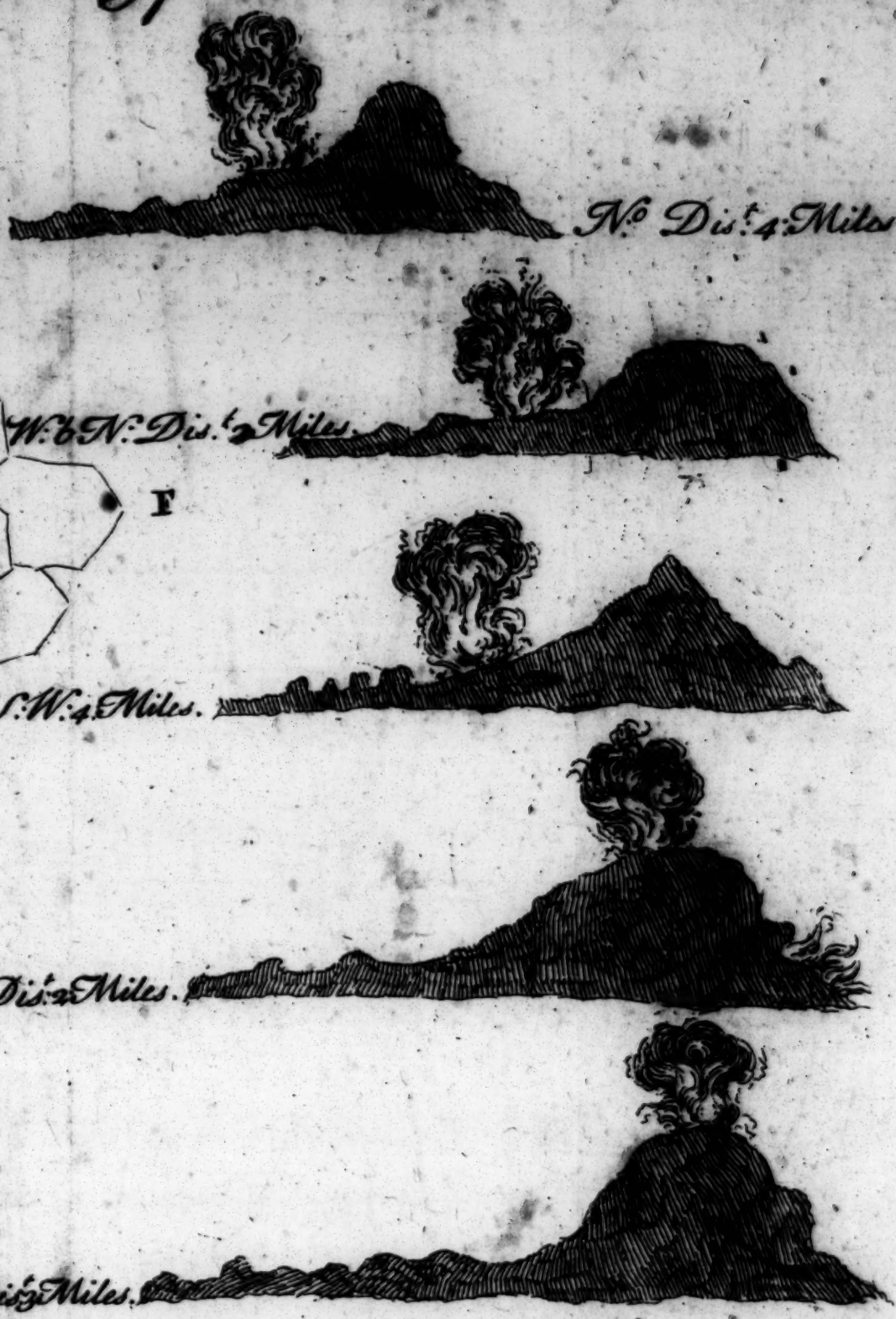


Fig. 2.







This Island is Almost Round and
Supposed to be about 2 Leagues in Diam.r
By Good Observation its Latitude is 38.29.
Its Longitude 26.33: The Bearing &
Making it in Sailing Round is Lagues
In The Draughts above

I Have ſent you, as you deſired, the Scheme of the *Parhelion*, with all the Notes that I cou'd take in the ſhort Time it continued, having been only out occaſionally, without any Inſtrument to compute the Proportions, or take Angles; ſo that my Obſervation cannot be exact, but only approach the Truth. However I can recollect nothing material, that I have omitted.

A. The Place of the Sun, being nearly Weſt about 12 or 13 D. above the Horizon, being about an Hour before Sun-ſet.

B. The luminous Spot, being about 30 D. to the Southward of the Sun, as near as I cou'd compute, having no Inſtrument to take the Angle, and in the ſame Parallel of Altitude; the Spot was not ſo well defin'd as in the Scheme, being more imperceptibly ſhaded off in the Cloud, the two ſemicircular Lines next the Sun were thoſe tinged with the Colours; the nearеſt the Sun being of a deep Scarlet, the inner one a deep yellow, both the Colours being ſoftned as they fell off from the Sun, all the reſt of the Spot being an intenſe Light, ſo as the naked Eye cou'd ſcarce bear it.

C. The other Spot to the Northward, which appeared ſometime after that marked B, being not quite ſo large, nor the Colours ſo intenſe, but the ſame way diſpoſed, thoſe next the Sun being red, the next yellow, and the reſt white.

D. A Spot in the Cloud, as it moved Southwardly, till it came to about 60 D. Diſtance from the Sun, which had the Colours as in the other Spots, that next the Sun being red, the next yellow, but much fainter than in the *Parhelia*.

The

E. The Appearance of two Segments of Circles, at about the ſame Diſtance from the Sun, as the *Parhelia*, being perpendicularly above it, the Colours being fainter than in the *Parhelia*, but the ſame Way diſpos'd, the lower Lines next the Sun expreſſing the red, and the upper the yellow.

The Colours at D, and E, as they were not ſo intenſe, neither were they quite ſo broad as thoſe at B and C; the two Colours being added together were about $\frac{1}{4}$ of the Disk at B, and the Colours in the ſame Proportion at C; the Diameter of the *Parhelion* at B, being about double the apparent Diameter of the Sun, as near as I could compute, as in the Scheme is expreſs'd.

The Centres of the Segments of the *Halo*'s mark'd E, if not in the *Parhelia*, were very little below 'em.

Below the *Sun* and *Parhelia* the Cloud was too thick to diſcover any thing thro' it; and above them, till near the Segments mark'd E, the Sky was ſerene and nothing obſcured; but at E, where the Rays, which pointed upwards from the Sun, terminated, it appear'd hazy, and ſo thick as to reflect the Colours.

Caſtle Dobbs,
April 2. 1722.

Arthur Dobbs.

II. *A Letter to the* Royal Society *concerning the Particles of Fat. By Mr.* Leeuwenhoek, *F. R. S. Tranſlated from the* Dutch *by* John Chamberlayne, *Eſq;*

Delft, *May* 1ſt, 1722.

I Take the Liberty to lay before you the following Obſervations, which I made about two Years paſt.

I have formerly ſaid, that the Matter which we call Meal, or Flower, in Wheat, Rye, Barley, Oats, and in all ſorts of Beans, is ſhut up as it were in little Cells or Chambers, and that thoſe little Cells are ſeparated from each other by thin Membranes, which are thinneſt in Wheat. And foraſmuch as in the Enquiry into what is called the *Perioſteum* of an Ox or Sheep, I have often broke in Pieces the fat Particles thereof, and as often viewed thro' a Microſcope the ſaid broken Particles, ſo have I likewiſe placed a few of the fat Globules upon a clean Glaſs Plate, and afterward held the ſaid Glaſs Plate over a Coal Fire, or the Flame of a Candle, ſo long, till they were all melted and reduced into a liquid Matter; ſo that not only the Fat, which was ſhut up in the Skin of the fat Globules, but likewiſe the Skin itſelf was reduced to a fluid Matter; and thereupon I immediately brought it before my Sight; and viewing it with Attention, perceived, when the melted Fat was cold, that there were different Matters inclos'd in the ſaid fat Globules; for as much as there appear'd an inconceivable great Number of exceeding ſmall coagulated Particles, and the reſt of the

Parts, of which the Fat was compoſed, lay in one ſmooth and even Subſtance, as I have formerly ſaid; and I have been conſidering whether there might not be incloſed in ſuch a Globule of Fat, ſo many little Cells and Partitions as we ſee in a little Grain or Seed, but if it be ſo, it will remain concealed from our Eyes.

But having now again carefully contemplated theſe coagulated Globules of Fat, many of which go to the making of one little Bubble, I did often fancy, that I ſaw, that each of the ſaid ſmall Particles was provided with ſuch a tranſparent Dent, as I have before ſaid, that the Meal Globules of Wheat, &c. are furniſhed with: From which Obſervation I ſaid to myſelf, ſince we find, that the great Creator of the Univerſe has made all his Creatures almoſt after the ſame manner; and that there grows no Plant whatever, let the Seed be never ſo ſmall, but there are inclos'd in it the ſame ſort of Particles as are found in bigger Seeds; and that tho' they differ in Magnitude, yet are they analogous one to the other: this being ſo, we may eaſily imagine, that a fat Globule has a Bark or Skin as well as any Seed, as we have often ſeen, and that they are furniſhed within with Particles analogous to thoſe of the Seeds, which we call Wheat, Oats, and the like; and altho' we render the Fat fluid by the help of Fire, yet will the ſmall Particles which are incloſed in the fat Globules, again reſume their former Figure, as I have formerly ſaid.

Yea I have fancied to myſelf, tho' it did not appear to my Sight, that each fat Particle is furniſhed with little Cells within, like the Seeds or Fruits of Plants.

Since I have ſet this down upon my Paper, I was informed that my Butcher had killed a Sheep of an uncommon Bigneſs, and that it weighed 140 Pounds, without the Fat that they took out of it, after it was

kill'd

kill'd, which weighed 51 Pounds, ſo that the whole Sheep weighed above 190 Pounds.

I cauſed a Piece of the Fat, that grew about the Kidneys of the ſaid Sheep, to be brought to me, imagining that its fat Particles would be of a coarſer Grain than thoſe of ordinary Sheep; for I have obſerved ſeveral times, that the bigger an Ox was, the larger were the fat Particles thereof; and ſince not one Man in a thouſand has any Knowledge of the Contexture of theſe fat Particles, for we find that there are not any two of one and the ſame Figure, they being compreſſed by other Particles with which they are ſurrounded, as I have frequently taken notice, I have cauſed ſome few of theſe fat Particles to be drawn here, as may be ſeem in *Fig.* 1. between A, B, C, D.

Now when we meet with one of theſe little Bundles of fat Particles, as has frequently occurr'd to us, in which the fat Particles were four times this Thickneſs; I imagine, that ſuch fat Particles cannot be produced out of one ſingle adipoſe Veſſel, but that out of ſuch a Veſſel ſeveral ſmall Sprigs iſſue forth, and out of each of thoſe ſmall Sprigs proceed others ſtill ſmaller, and that out of theſe Particles one larger fat Particle is formed like a Bunch of Grapes.

Now I cut off with a Razor the Fat in ſeveral Places of a greater Piece, as thin as I could, laying the thin Pieces upon ſeveral Glaſs Plates, and put them upon a Coal-Fire, ſo as to cauſe them to melt; and being melted, immediately viewed them with a Magnifying-Glaſs, when I obſerved the Skins, or membranous Coats, of the fat Globules lying among the melted Particles, and in the ſaid melted Particles there was nothing to be perceived but a limpid Matter ſurrounded with ſmall Air-Bubbles; but when the Fat was congealed, we could obſerve but very little of the Mem-

 branes,

branes, becauſe they were covered with the Particles of Fat, with which theſe Membranes or Skins had before been filled.

I cauſed a few of theſe Skins of the fat Globules to be drawn, as may be ſeen here at *Fig.* 2. between E, F, G, H. During the ſaid Obſervation, I fix'd my Eye with attention upon the fat Particles of the Sheep which had been melted, and were again coagulated; and I could not but judge, that theſe fat Particles, which were exceeding ſmall, were analagous to that internal Matter, wherewith ſome of the ſmalleſt little Seeds are furniſhed, and in a great many of theſe exceeding ſmall Particles, I could in clear Weather diſcover ſome Tranſparency.

Moreover, I cut as thin Slices as it was poſſible of the Fat, yea ſo thin, that five or ſix of them did not weigh a Grain, and put them into a little Water, in order to try whether I could make any farther Diſcoveries thereby, with reſpect to the ſmall Particles of Fat; but it was in vain: only I ſaw floating upon the Water very ſmall Particles of Fat, which were coagulated in a ſpherical Figure, and the very biggeſt of thoſe fat Particles was no bigger than a Grain of Sand. I placed theſe Particles upon a Glaſs Plate; and viewing them with a Microſcope, I obſerved the Figure, which I mention'd above, as plain as before; and other fat Particles ſeemed to be of a different Figure. I put one of theſe into the hands of my Painter, or Deſigner, bidding him to draw what he obſerved, it being the Figure of one of the ſaid fat Particles, which was coagulated on the Water, as it is repreſented here by *Fig.* 3. between I, K, L, M, which was not very conformable with the other melted fat Particles; for in the doing it, all the Particles did not melt, for the fat Particles are not all extracted by the Water, and coagulate

agulate upon the Water in ſmaller and greater globular Particles; and when we take out of it the Remainder of the thin Slices of Fat, which float upon the Water, and view them with a Microſcope, we find that many of the fat Particles appear intire to the Eye; and whereas they were before very ſmooth and even in their Sides, they were now changed into rough and uneven Particles; ſo that one ſhould be apt to think, that there were two different ſorts of Particles in the Fat, and that one ſort melted more eaſily than the other.

Now in order to get theſe melted Particles of Fat out of the Water, without altering them, I made uſe of a round Glaſs, and with it skimm'd the Superficies of the Water; by which means ſome of the coagulated Particles ſtuck to the Glaſs. Moreover, I did again melt ſome of the fat Particles, which had been coagulated upon the Water, over a Coal Fire, as they lay in the Water; and when they were again coagulated, viewing them with a Microſcope, I found the ſmall fat Particles to be yet ſmaller than thoſe that were melted out of the Water.

In this laſt Obſervation I obſerved, with aſtoniſhment, the inconceivable Number of Veins and Membranes, which were diffus'd through the Fat, and the Multitude of ſeparated fat Particles, that were involved in their ſeveral Membranes.

After this, there was laid before me the Hind-Quarter of a ſucking Lamb, over which was ſpread what we call the Net, or Caul; and having cut off ſome Pieces of the ſaid Net, or Caul, upon which there was little or no Fat, with a Pair of Sciſſars, and placing them before a Microſcope, I obſerv'd again, that the fat Particles, where there were very few of them included between the Membranes, were of a more globular

globular Figure than in other Parts, where a good many lay together, and that in other Places they were preſſed or bruiſed, which I fancy was occaſion'd by the Butcher's ſqueezing the Caul in that place with his Fingers; and in another Place the fat Particles had been ſo torn in pieces, that I could ſee nothing remaining but the Skins of the fat Globules.

Moreover, I ſaw that the fat Particles had ſuch a Pinch, or Dent, in them, as I have ſhewn, that there were in the Globules of Flower of Wheat; from which Spectacle, I am confirmed more than before in my Opinion, that the fat Globules might be ſeparated intirely, or in part, from the Skin with which they are ſurrounded, by opening the Dents, without breaking the Skin.

Then I took off the thin Membranes, which encompaſs'd the fat Particles, and viewing them with a Microſcope, obſerved, that the fat Particles had imprinted a roundiſh Figure on the Membranes, inclining to a hexangular Shape, that it was a Pleaſure to look on 'em; but in other Parts they were of an oval Figure.

Moreover, I took a flat Fiſh, which we call *Plaiſe*, and took off the Fat which adher'd to the Veſſels, or Bones, and viewed it with a Microſcope, and obſerved, that the Fat Particles were of ſeveral Sizes; and ſome were ſo ſmall, that I judged that fifty of the leaſt were no bigger than one great fat Globule; and moreover, I ſaw that many of the fat Globules had ſuch a Pinch in them, as we find in the Meal, or Flower, of thoſe little white Beans, which we call *French* or *Kidney-Beans*.

Afterwards my Servant brought to me the Fat of a *Perch*, which was nine or ten Inches long, and taking a little of it, I viewed it with a Microſcope, but could not diſcover any ſmall Particles in it, nor any

internal Dent, as I had obſerved in the Fat of a ſmall *Plaiſe*.

After that the Fat of the *Perch* had lain an Hour or two upon the Glaſs, I viewed it again, and obſerved that the Particles were leſſened, or become ſmaller, and that the Skin of the fat Particles, which as yet was beſet with ſome fat Particles, was, as it were, ſhrunk, or wrinkled, and the Fat that was burſt out, lay about the fat Particles, and was ſo fluid and tranſparent, that we could not diſcover any Parts in it.

From this Obſervation I began to think, whether each of theſe fat Particles was not provided with an Orifice, or Hole, out of which the Fat might be protruded at all times, as often as the Parts of the Fiſh ſtood in need of Nouriſhment, without an entire laying open the Skin of the fat Globules; for we conſtantly find, that when the Eggs of the Perch, which we call the Roe, increaſe in Bigneſs, its Fat decreaſes; yea in ſuch a manner, that when the ſaid Eggs, or Roe, are arrived at their utmoſt Bigneſs, there is ſeldom or never any Fat to be ſeen upon the Inteſtines of the Fiſh.

Thus far my Notes go about Fat; and if my Health will allow me, I ſhall ſhortly tranſmit to you ſome more of the Obſervations which I have ſet down in writing.

III. *Part of a Letter from* Thomas Forſter, *Eſq*; F.R.S. *to Mr.* Machin, *Prof. Aſtron. Greſham, Secr. R. S. concerning a new Iſland lately raiſed out of the Sea near* Tercera.

London, *May* 12. 1722.

I Here ſend you a Draught of the ſeveral Bearings, and the Captain's Account of an Iſland lately broke out of the Sea, bearing S. E. from *Tercera*, Diſtance 17 Leagues.

John Robinſon, being Maſter of a ſmall Pink-Snow, called the *Richard and Elizabeth* from *Piſcataqua* in *New-England*, arrived at *Tercera*, *Decemb.* 10. 1720. near which Iſland he ſaw a Fire break out of the Sea. The Governor hired him to go with the ſaid Veſſel to view it, and ſent on Board ſixteen Sailors, and two Prieſts. On *Sunday*, the 18th of *Decemb.* we got under Sail at 12 o' Clock at Night, and ſtood from *Angras*, S. E. The next Day at two o'Clock in the Afternoon, we made an Iſland all Fire and Smoak: we continued our Courſe till the Aſhes fell on our Deck like Hail or Snow all Night. We bore from it, the Fire and Smoak roared like Thunder, or great Guns. At Break of Day we ſtood towards it again: at 12 o'Clock we had a good Obſervation, two Leagues South from it. We ſail'd round it, and ſo near, that the Fire and Matter it threw out, had like to have done us Damage: In which Conſternation we all betook our ſelves to Prayers, being in danger of driving a-ſhoar: then a ſmall Gale, at S. E. ſprung up, and carried us clear to our great Joy. The Breeze was ac-

companied with a ſmall Shower of Rain, which caus'd a great Duſt to fall on our Deck; with the ſaid Breeze we ſtood away for *Tercera*. The Governor inform'd us that the Fire broke out the 20th of *Nov.* 1720. in the Night, and that the prodigious Noiſe it made, caus'd an Earthquake, which ſhattered down many Houſes in the Town of *Angra*, and Places adjacent, to the great Terror of the Inhabitants. We took ſeveral Draughts of the Iſland at ſeveral Bearings in our ſailing round, of which the incloſed is a Copy. Prodigious Quantities of Pumice-Stones and half-broil'd Fiſh were found floating on the Sea, for many Leagues round the Iſland, and abundance of Sea-Birds hovering about it. So far the Captain.

An Acquaintance of mine informed me, that in his Paſſage from *Cadiz* to *London* (the latter end of *April* was 12 Months) he obſerved the Sea from Cape *Finiſter*, almoſt to the Chops of the Channel, to be covered with Pumice-Stones, ſome of which he gave me.

IV. *A Letter from Mr.* Ralph Thoresby, *F. R. S. to Sir* Hans Sloane, *Bart. Preſident of the College of Phyſicians, and Vice-Preſ. R. S. concerning the Effects of a violent Shower of Rain in* Yorkſhire.

THE Effects of a violent Shower of Rain at *Riponden*, near *Halifax*, were ſo ſurprizing, that I wrote to a Gentleman in thoſe Parts for an Account that might be depended upon; and particularly deſired to know, whether there was not an Eruption of

Waters out of the Hills, as the late ingenious Mr. *Townley* of *Townley* wrote me there was out of *Pendle-Hill*, in that at *Star-bottom* mentioned in the *Philoſ. Tranſ.* N° 245. but all the Account I can learn of this is, that what they call the Daſhing of two great watery Clouds upon the Hills, occaſioned the Inundation; what ever was the more immediate Cauſe, the Effects were diſmal, and ſo ſudden, that tho' it was upon the Day-time, the poor Creatures could not ſave their Lives. This Calamity happen'd the 18th of *May*, 1722. betwixt the Hours of 3 and 5, when by the modeſteſt Account the Beck was rais'd two Yards at leaſt in perpendicular Height above what was ever known before; which may be eaſily conceived by the Situation of the Place implied in the Termination *den*, which ſignifies a deep Valley between pretty ſteep Hills on each Side. *Fontes in convallibus*, is in the *Saxon* Verſion rendered pillaſ on ðenum *Pſ.* ciij. 2. and *Valley of Tears*, (as this now) *Pſ.* lxxxiij. 6. ðene ðeopa. Several Houſes, four Mills, (ſome ſay ſix) nine Stone-Bridges, and ten or eleven of Wood, are taken down, and the Wheels, Dams, and Sluices, (*Eboracentibus* Goits, from the verbal Noun ȝeotan *fundere*) of moſt of the Mills that are left ſtanding, broken and damaged; and a great deal of Cloth gone. Fifteen Perſons were drown'd, of whom *Jonas Longbothom* and his Servant are not yet found. Seven out of eight in one Houſe were either ſlain by the Fall of it, or drowned. A young Man eſcaped by help of a piece of Timber, was turned over and over again, in paſſing two or three Dams, but at laſt taken out alive, tho' diſtracted for the preſent; but it's hoped he may recover.

The Rapidneſs of the Torrent was ſo violent, that it took down the North-ſide of *Rippondon* Chapel, and carried off moſt of the Seats. A Man of *Denſbury* told

told me, that he saw four of them that were driven to that Town; and the Rector of *Castleford*, who visited me the Day after, inform'd me, that many Goods were carried down so far, tho' above 20 Miles off. It tore up the Dead out of their Graves; at first I was willing to believe it only of an old Woman that had been buried that Afternoon, and so the Earth not fully settled again; but am since informed by a sure hand, that two corrupted Corpses were driven upon one Gentleman's Land, and as many upon another's. It swept away all the Corn-Land, as deep as the Plow had gone. Some Persons sav'd themselves by forcing a Way out of the Roofs of their Houses, and sitting upon the Ridges till the Floods abated.

I was that Day seized by a smart Thunder-Shower, upon the Moor, as I was coming home.

Leeds, June 5. 1722.

V. *Part of a Letter from Mons.* Couzier, *Physician in the Infirmaries at* Alais, *to Dr.* Deidier, *Professor of Chymistry in the University of* Montpelier, *concerning a new Experiment made with the Blood of a Person dead of the Plague. Communicated to the Royal Society by Dr.* Woodward, F. R. S. *Prof. Med. Gresh.*

ON the First of this Month I took an Opportunity of beginning the Experiments you had recommended to me, and of which I had promised to give you an Account.

I took a Quantity of Blood from the Body of a Perſon dead of the Plague, and mix'd it with warm Water, which Mixture I attempted to inject into the Crural Vein of a Dog, but the End of the Syringe being too large to enter the Vein, the Experiment did not ſucceed.

This made me reſolve to try the other Method you had propoſed to me, which was to lay ſome of the ſame infected Blood upon the Wound. This I accordingly did, and cover'd it with a Dreſſing, which the Dog got off in the Night. I found the next Morning that the Dog had lick'd his Wound, and that he refuſed his Food. Towards Night he began to bemoan himſelf, and gave Signs of an approaching Death. The next Morning I found him dead, the Wound being conſiderably ſwell'd and gangren'd, and the Edges round the Swelling were likewiſe gangrened.

Upon opening the Body we found the Liver ſomething larger than uſual, with Spots of a livid Purple, as in the Bodies of Perſons dead of the Plague. In the Stomach was found a Quantity of black coagulated Blood, of the Size of a Hen's Egg. This in all Likelihood was what he had ſwallow'd upon licking the Wound. The Heart was very large, with a black grumous Blood in the Ventricles, and the Auricles were turn'd blackiſh and gangrenous.

Alais, April 3.
1722.

VI. *Ex-*

VI. *Extract of a Letter from Dr.* Deidier, *concerning an Experiment made with the Bile of Persons dead of the Plague. Communicated by Dr.* Woodward.

WE cauſed two Dogs to ſwallow a pretty large Quantity of the Bile taken from the Bodies of Perſons dead of the Plague.

Upon this the Dogs appeared heavy and melancholy, refuſed their Food, and made Water very often, eſpecially when they were any ways diſturb'd. Their Urine was thick and very fetid, and their groſs Excrements were tinged with the black and greeniſh Bile, which they had ſwallow'd. But in a few Days thoſe Accidents went off, and the Dogs recovered their perfect Health, though they were all the Time confin'd in a Cellar belonging to the Diſpenſary, in company with the other Dogs that we tried our Experiments upon.

Montpelier, April 28. 1722.

VII. *So-*

VII. *Solutio Problematis de curvis inveniendis, quæ quadam ratione in ſitu inverſo diſpoſitæ ſe interſecare poſſunt in angulo dato.*

JAM primum ad manus pervenerunt *Acta Eruditorum* ad hunc menſem *Auguſti*, ubi invenio a me peti, ut ea aperiam, quæ notis fictis celata in *Supplementorum ad Acta Eruditorum*, Tom. 8. Sect. 1. edita ſunt. Explicentur autem ea tabulâ ſequenti.

	z	y	x	v	u	t	s	r	q	p	o	n	m	l	j	i	h	g	f	e	d	c	b	æ	a
b	a	4	o	æ	i z	u	r	s	j	c	8 t	y	9	2	6	e p	3	m	f	7 l	v	w	5	r	h d
g	e	o	u	w	4 d	3	i	c	6	2	s z	7	5	y	æ	m t	1	r	j	9 p	a	h	v	8	f l
n	i	j	æ	5	o l	1	r	s	e	v	6 d	f	a	h	4	y z	w	u	7	9 t	3	8	c	m	z p
q	o	8	3	u	v p	6	æ	1	c	w	h l	i	5	m	z	j d	f	e	9	a z	4	y	7	s	r t
x	u	y	4	1	c t	f	w	j	2	o	8 p	s	7	r	3	f l	m	i	h	e d	g	æ	a	6	v z

In hac tabulâ ſex ſunt notarum ordines: ſupremus literas continet, quibus verba celata ſcribi debent, reliqui literas numeroſque continent, quæ verarum literarum loco uſurpantur. Literas autem b, g, n, q, x, quæ e lævâ horum ordinum inferiorum collocantur, propter earum uſum indices appellare licet. Scripturæ pars celata ab horum indicum duobus incipit, quorum poſterior oſtendit notas illum ſequentes in eo ordine, cui præfigitur, quæri oportere, ut veræ literæ cognoſcantur, quæ ſupra has notas in ordine literarum primo

primo ſemper habentur: Ex hoc autem ordine notæ fictæ deſumendæ ſunt, donec alteri alicui indicum occurritur, quod cum fit, hoc novo indice utendum eſt ut priori. Et hac regulâ tota ſcriptura explicabitur, niſi quod quandocunque plures indices ſunt contigui, omnes præter ultimum negligi debent: item verborum aperte ſcriptorum interpoſitio hunc indicum uſum non turbat. Hoc modo ſcriptura occulta, ſi pauci errores typographici emendentur, verba ſequentia complecti invenietur.

Curvarum, quæ problemati conveniunt, quæcunque ſumatur ordinata, illius fluxio ſecunda ab ejuſdem fluxione primâ diviſa (ut ſermone arithmeticorum utar) eandem dat quotientem, ſed contrario ſigno, ac fluxio ſecunda a fluxione primâ diviſa ordinatæ ex alterâ principii abſciſſæ parte jacentis, & ad eandem ab eo principio diſtantiam. Hujuſmodi autem curvæ inveniri poſſunt tribus regulis.*

Prima regula curvam, qualem problema requirit, ope ſpatii hyperbolici à curvâ quacunque deducit, quæ habeat ad æquales diſtantias a principio ſuæ abſciſſæ ordinatas æquales, & ab eâdem parte abſciſſæ poſitas. Eſt enim ordinata curvæ quæſitæ, ut area alius curvæ ordinatam habentis æqualem ſegmento aſymptoti hyperbolæ terminato a ſpatio hyperbolico æquali areæ curvæ primo aſſumptæ.

Regula autem ſecunda pendet a primâ, & curvam problemati ſatisfacientem ſine ope ſpatii hyperbolici ex curvis derivat, quæ habeant ad æqualia intervalla a principio ſuæ abſciſſæ ordinatas æquales, ſed a contrariis partibus abſciſſæ poſitas.

---

* Scilicet, ſi abſciſſa a ſuo principio in oppoſitas partes æqualibus momentis fluit.

Et hæc ſecunda regula theorema ſequens præbet, nimirum, ſi aliqua curva ſumatur, qua problema ſolvi poſſit per regulam primam, & ſi hujus ordinatæ inſiſtunt abſciſſæ ad perpendiculum, invenietur curva problemati ſatisfaciens, ſi ad eandem abſciſſam conſtruatur alia linea curva, eâ lege, ut illius ordinata ex alterâ parte abſciſſæ ubique æqualis ſit aggregato aſſumptæ lineæ curvæ & ejuſdem ordinatæ; exceſſui autem hujus curvæ præ ordinatâ ſuâ æqualis ſit unaquæque curvæ conſtruendæ ordinata, quæ ex alterâ parte abſciſſæ jacet; omnes enim curvæ hac ratione conſtructæ problemati conveniunt.

Hoc autem theorema demonſtratur propoſitione ſequenti, quod in omni triangulo rectangulo quadratum ab alterutro latere angulo recto adjacenti æquale eſt rectangulo ſub ſummâ alterius lateris angulo recto adjacentis lateriſque angulo ei ſubtendentis, & ſub differentiâ eorundem laterum.

Denique tertia regula derivatur a ſecundâ, ope propoſitionis nonæ libri de quadraturâ curvarum Neutoni.

SCHOLIUM.

Exemplum generale, quod exhibui, curva logarithmica, & cyclois plurimis modis inveſtigari poſſunt his regulis.

Unus caſus curvæ logarithmicæ commode invenitur per regulam primam, aſſumptâ lineâ rectâ loco curvæ in illâ regulâ memoratæ.

Alter hujus lineæ caſus deducitur ex regulâ ſecundâ ope ſpeciei quinquageſimæ nonæ linearum tertii ordinis, quæ omnium curvarum in illâ regulâ utilium eſt fere ſimpliciſſima præter parabolam cubicam & hyperbolam conicam.

Cyclois



Yo

I. Senex sculp.t.

Fig: 1.

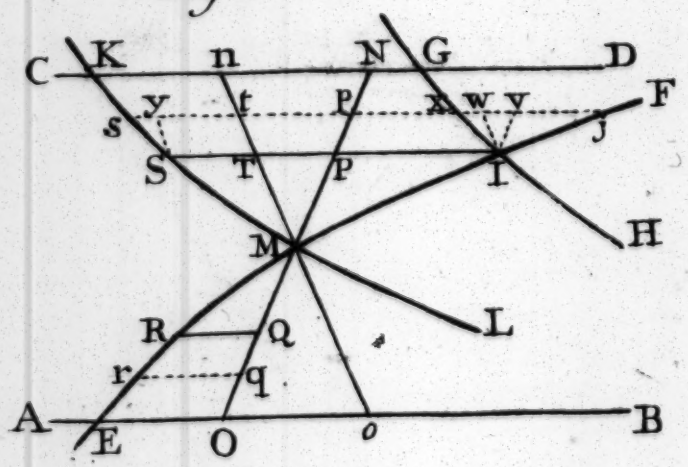


Fig. 2.

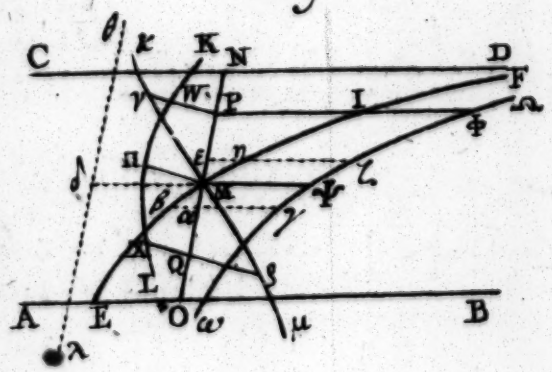
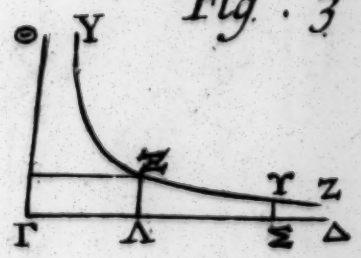


Fig. 3.



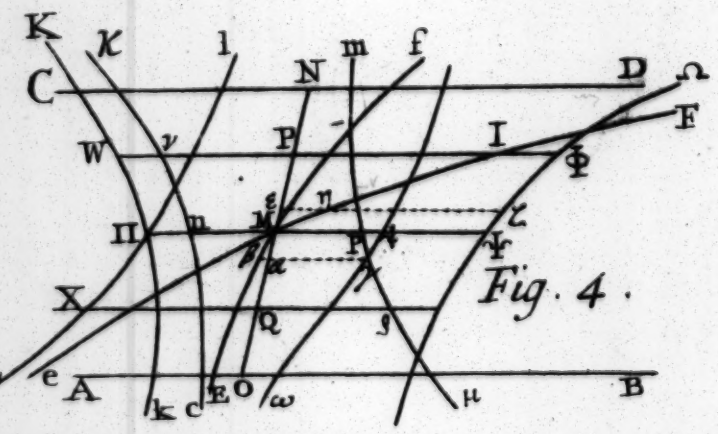


Fig. 4.

Fig. 5.

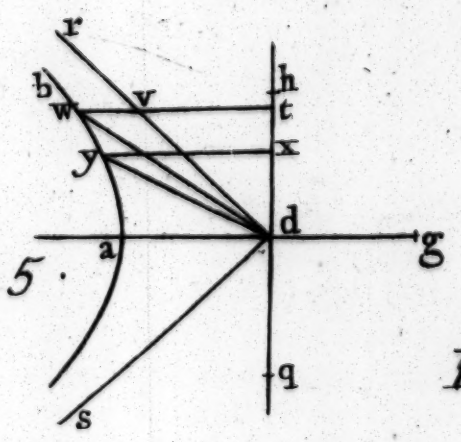


Fig. 6.

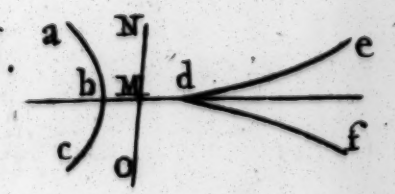
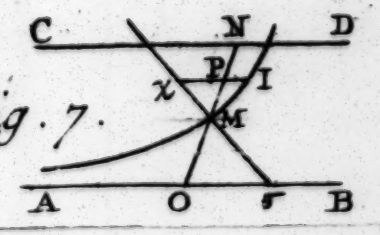


Fig. 7.



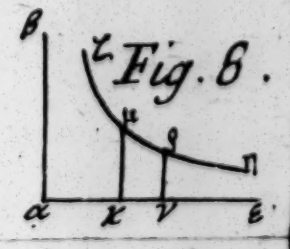


Fig. 8.

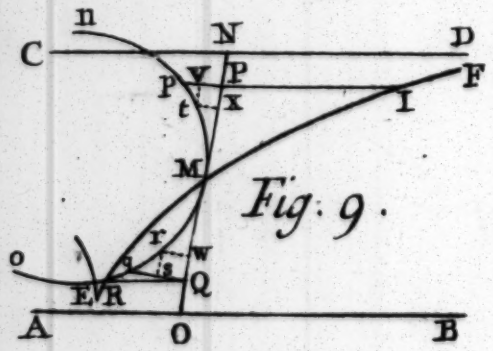


Fig. 9.

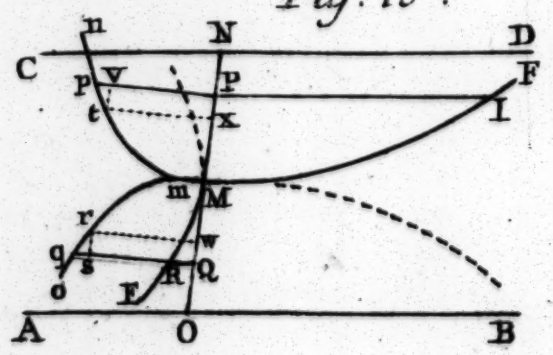


Fig. 10.

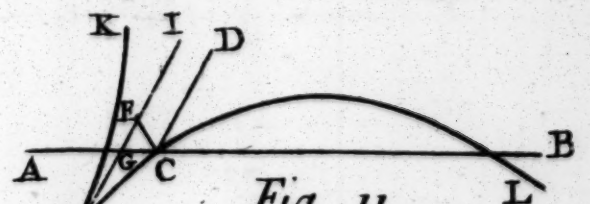


Fig. 11.

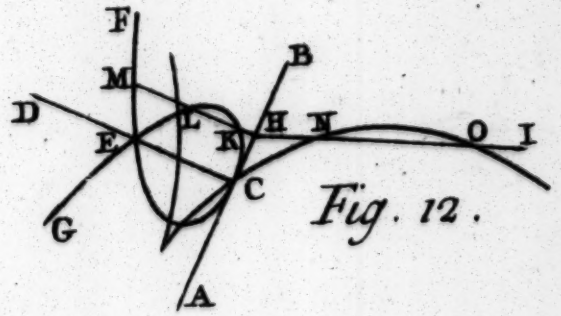


Fig. 12.

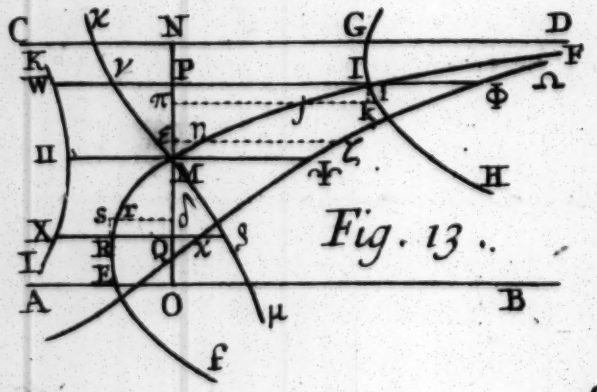


Fig. 13.

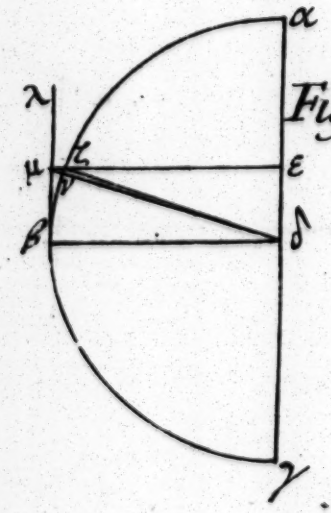


Fig. 15.

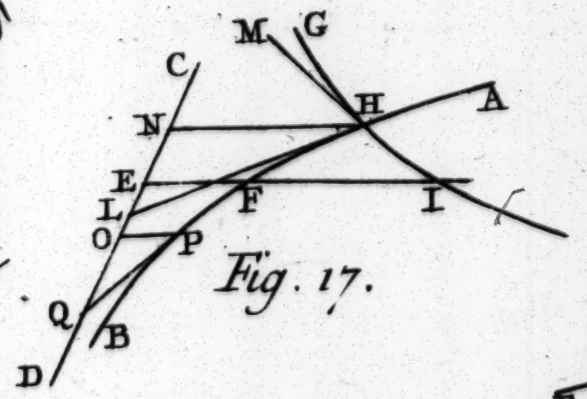


Fig. 17.

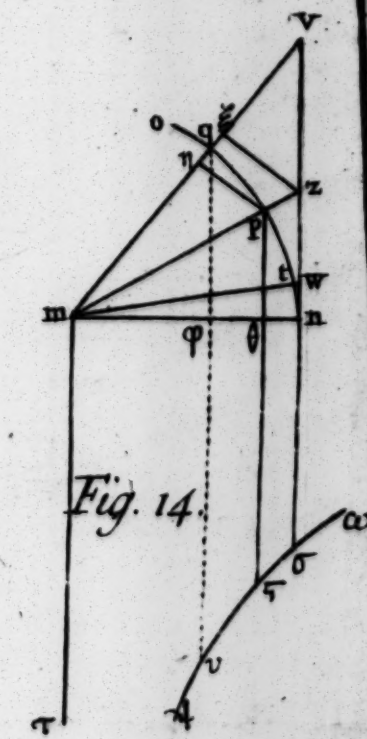


Fig. 14.

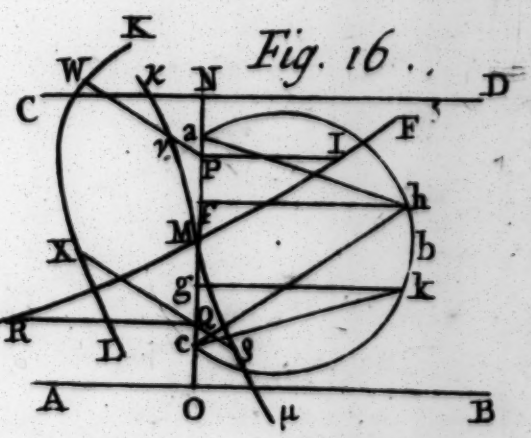


Fig. 16.

Fig. 20.

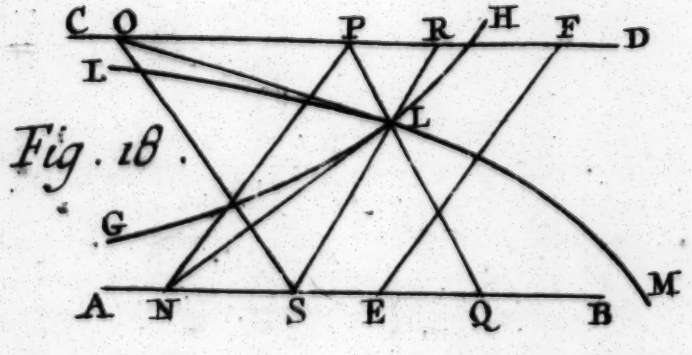


Fig. 18.

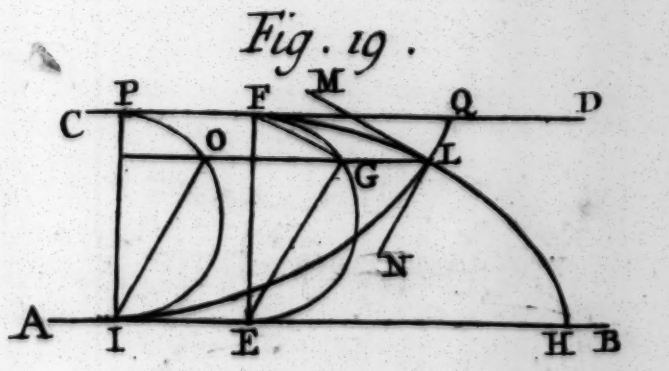


Fig. 19.

I. Senex sculp.t.

Cyclois optime invenitur theoremate, quod a regulâ ſecundâ deduci diximus.

Exemplum iſtud generale facile invenitur regulâ tertiâ, aliis vero regulis non ſine ambagibus.

Regulis ſecundâ & tertiâ commodiſſime inveniuntur curvæ geometrice rationales; quæ deducuntur etiam a theoremate in regulam ſecundam pendente; quandocunque enim curva aſſumpta tam longitudinem quam ordinatam rationalem habet, cujuſmodi ſimpliciſſima eſt parabola ſemicubica, curvæ quoque inveniendæ ordinata rationalis erit.

Denique his regulis, vel etiam conditione in principio poſitâ facile eſt invenire, an curva aliqua propoſita problemati ſatisfaciet, & quibus poſitionibus id fiet: unde intelligi poteſt, an eadem curva diverſis modis problemati conveniat.

Horum brevem explicationem jam apponam, deſcribendo, ex amici chartâ, problematis ſequentis ſolutionem.

PROBLEMA.

Datis duabus lineis rectis AB, CD (in *Fig.* 1.) parallelis, ad abſciſſam AB curva EF deſcribenda eſt, quæ talis ſit, ut in ſitu inverſo ad abſciſſam CD deſcripta ſeipſam ſemper interſecet in angulo quolibet dato.

Ad abſciſſam CD deſcribantur curvæ GH, KL ſimiles & æquales curvæ EF, quarum altera huic curvæ EF occurrat in puncto quolibet I, altera vero per punctum M tranſeat, ut partes EM, KM curvarum EF, KL ſimiles ſint & æquales; & per punctum M, quod partes curvæ EF dirimit, quæ ſe mutuo interſecare debent, ducantur lineæ NMO, nMo, quæ cum rectis AB, CD angulos ſub NOB & ſub CNO, item angulos ſub noA, & ſub onD conſtituant ei æquales, in quo curva ſeipſam ſecare ponitur. Ducatur IPTS lineis AB, CD parallela;

lela; item huic proxima & parallela j x p t s; deinde ducatur I v lineæ N O parallela, & denique I w, S y parallelæ lineæ n o, ut angulus ſub I w j æqualis ſit angulo ſub I v x. Jam anguli ſub I x w & ſub I j v ſimul ſumpti æquales erunt angulo ſub x I M, ideoque & angulo ſub I w v æquales; unde angulus ſub x I w æqualis erit ei ſub I j v; & eodem modo angulus ſub j I v ei ſub I x w æqualis invenietur; adeo ut triangula I j v, x I w ſunt ſimilia, & j v : I v : : I w : w x. Porro pro abſciſſis æqualibus M P, M T ſcribatur z, pro ordinatâ P I, y, & $-v$ pro ordinatâ T S, pertinente ad curvæ K L arcum K M, qui arcui E M curvæ E F reſpondet. Creſcentibus autem abſciſſis M P, M T, & ſimul increſcentibus ordinatis P I, T S, earum fluxiones primæ eadem habebunt ſigna cum ſuis ordinatis, ſed utræque fluxiones ſecundæ idem habebunt ſignum; nam fluxio ſecunda unius ordinatæ idem habebit ſignum cum ſuâ ordinatâ, ſed alterius ordinatæ fluxio ſecunda ſignum habebit a ſigno ſuæ ordinatæ diverſum; propterea quod curvarum K M, M F alterius concavitas verſus convexitatem alterius convertitur, ut manifeſtum eſt. His autem cognitis invenietur j v : I v ($=$ P p) : : $\dot{y} : \dot{z}$, I w ($=$ T t) : w x ($=$ s y) : : $\dot{z} : -\dot{v}$, & $\dot{y} : \dot{z} : : \dot{z} : -\dot{v}$, item $-\dot{y}\dot{v} = \dot{z}^2$, & denique poſitâ $\dot{z}$ invariabili $-\dot{y}\ddot{v} - \ddot{y}\dot{v} = 0$, vel $\dot{y}\ddot{v} + \ddot{y}\dot{v} = 0$, ideoque $\frac{\ddot{y}}{\dot{y}} = -\frac{\ddot{v}}{\dot{v}}$, quando $\dot{y}$ & $\ddot{y}$ ad curvam E F, ſed $\dot{v}$ & $\ddot{v}$ ad curvam K M pertinent. Idem vero locum quoque habet, quando omnes hæ fluxiones ad curvam E F referuntur, ſi abſciſſa in oppoſitas partes a ſuo principio fluere ſtatuitur; nam ſumptâ M Q $=$ M P, & M q $=$ M p, ductiſque Q R, q r ad A B, C D parallelis, puncta R, r in curvâ E F punctis S, s in curvâ K M reſpondent. Ponendo igitur abſciſſam in contra-

contrarias partes a ſuo principio æqualibus momentis fluere, *Curvarum, quæ problemati conveniunt, quæcunque ſumatur ordinata, illius fluxio ſecunda a fluxione primâ diviſa eandem dat quotientem*, &c. ut ſupra. Hæc autem curvarum quæſitarum conditio eſt, unde deducuntur regulæ ſequentes ad problematis ſolutionem.

Regula Prima.

CUM requiritur, ut M Q exiſtente = M P fit $\frac{\ddot{y}}{\dot{y}} = -\frac{\ddot{v}}{\dot{v}}$, quando abſciſſa in oppoſitas partes a puncto M æquabiliter fluit, ita ut ejus fluxioni in partibus abſciſſæ, quæ a contrariis lateribus puncti M jacent, ſigna diverſa tribuenda ſint, ponere licet $\frac{\ddot{y}}{\dot{y}} = \dot{z}$ ductæ in quantitatem quamcunque, quæ eadem maneat, & ſub eodem ſigno, pro eâdem magnitudine z, ſive illa affirmativa ſive negativa ſit. Deſcribatur igitur (in *Fig.* 2.) ad abſciſſam N O curva quælibet K L, cujus ordinatæ angulum quemcunque datum cum abſciſsâ conſtituant, & quæ habeat eas ordinatas æquales, & ab eodem latere abſciſſæ N O poſitas, quæ æqualiter diſtant a puncto M, ut ordinatæ P W, Q X; deinde fiat $\frac{\ddot{y}}{\dot{y}}$ ordinatæ P W × $\dot{z}$ proportionalis, & $\frac{\ddot{v}}{\dot{v}}$ ordinatæ Q X × $\dot{z}$.

Jam (in *Fig.* 3.) exponatur hyperbola Y Z ad afymptotos Γ Δ, Γ Θ, angulum ſub Θ Γ Δ angulo dato ſub N P W æqualem comprehendentes, deſcripta, & in alterutrâ afymptoto, ut Γ Δ, ſumatur ad libitum punctum Λ, & ducatur Λ Ξ alteri afymptoto Γ Θ parallela, & parallelogrammum Γ Ξ compleatur : deinde in curvâ K L ad abſciſſam N O, & ad punctum M ordinatim

 applicetur

applicetur M Π; ſumatur ſpatium hyperbolicum Λ Ξ Υ Σ, rectâ Σ Υ aſymptoto Γ Θ parallelâ abſciſſum, æquale ſpatio W P M Π, & fiat P Φ = Γ Σ, eâque ratione deſcribatur curva ω Ψ Φ Ω; dico P I curvæ quæſitæ ordinatam eſſe ut ſpatium M P Φ Ψ. Hoc autem manifeſtum eſt; fluxio enim ſpatii M Π W P æqualis eſt fluxioni ſpatii Λ Ξ Υ Σ, ideoque P W × ż = fluxioni lineæ Γ Σ ductæ in Σ Υ vel in $\frac{\Gamma\Lambda \times \Lambda\Xi}{\Gamma\Sigma}$; erit igitur P W × ż ut fluxio lineæ Γ Σ ſive lineæ P Φ per ipſam P Φ diviſa; ſed P W × ż eſt ut $\frac{\ddot{y}}{\dot{y}}$; unde erit P Φ × ż ut $\dot{y}$, & neceſſario y ſive P I ut ſpatium M P Φ Ψ. *Prima* igitur *regula curvam, qualem problema requirit, ope ſpatii hyperbolici*, &c. ut ſupra.

In exemplum hujus regulæ loco curvæ K L (in *Fig.* 2.) ſumatur linea recta lineæ N O parallela, & erit linea ω Ψ Φ Ω ea, quæ logarithmica dicitur, cui N O aſymptotos eſt; ideoque & linea E F etiam logarithmica, per punctum M tranſiens, & aſymptoton habens lineæ N O parallelam; propterea quod area M P Φ Ψ hic erit ut P Φ — M Ψ (*a*). Si vero ordinatæ ε η ζ, β α γ ducantur æqualiter diſtantes a puncto M, ordinatæque M Ψ proximæ, erunt ε η, α β æquales quando primum naſcuntur, quoniam ſpatia ε ζ Ψ M, M Ψ γ α tunc æqualia ſunt; ex oſtenſis autem eſt ε η × α 6 = M ε q vel M α q, unde ε η = M ε; & ε η ad $\frac{M\Psi \zeta\eta}{M\Psi}$ ut radius ad ſinum anguli ſub N M Ψ. Quoniam igitur P I ſemper eſt ut ſpatium Ψ M P Φ, erit P I ubique ad $\frac{\Psi M P \Phi}{M\Psi}$ ut radius ad ſinum anguli ſub N M Ψ; &

(*a*) Vid. Barrov. Lection. Geometr. p. 123.

denique

denique limes ordinatarum negativarum ad ſpatium totum comprehenſum a parte Ψ ω lineæ logarithmicæ ω Ψ Ω ab ordinatâ M Ψ, & ab aſymptoto M O ad ordinatam M Ψ applicatum ut radius ad ſinum anguli ſub N M Ψ : eſt autem rectangulum ſub M Ψ & ſub lineæ logarithmicæ ω Ψ Ω ſubtangente ad ſpatium prædictum etiam ut radius ad ſinum anguli ſub N M Ψ : adeo ut limes ordinatarum negativarum lineæ curvæ E F æqualis erit huic ſubtangenti ; unde ſi Ψ M retro producatur ad δ, ut M δ huic ſubtangenti ſit æqualis, & ducatur θ δ λ lineæ N O parallela, erit illa curvæ E F aſymptotos ; erit autem curvæ hujus E F ſubtangens lineæ M δ æqualis ; propterea quod M ε = eſt ε n. *Unus* igitur *caſus curvæ logarithmicæ commode invenitur per regulam primam*, &c. ut ſupra.

Hæc autem regula primum oſtendit modum, quo problema ſolvitur.

Regula Secunda.

Deſcribatur curva quæcunque ϰ M μ per punctum M tranſiens in *Fig.* 2. vel ϰ n c, m p μ in *Fig.* 4. ubi curva invenienda duobus cruribus e M F, E M f conſtat ; ut curvarum ϰ M μ, & ϰ n c, m p μ ordinatæ ut P ν, Q ρ, quæ æqualiter a puncto M principio abſciſſæ diſtant, ſint æquales, ſed a contrariis partibus abſciſſæ poſitæ, ita ut mutato abſciſſæ ſigno ordinatæ ſignum etiam mutetur.

Exponatur porro (in *Fig.* 5.) hyperbola æquilatera a b cujus axis tranſverſus a g, conjugatus h q, centrum d, aſymptoti d r, d s ; ſumatur d t = P ν, & ducatur t v w ad h q perpendicularis, junctâ d w, ſumatur quoque d x = M n, & ducatur x y item rectæ lineæ h q perpendicularis, junctâ d y. Jam ſit curva K L (in *Fig.* 2.) vel K k L l (in *Fig.* 4.) talis ut ſpatium

ΠMPW æquale ſit ſpatio a d w, ſi curva $z\mu$ per punctum M tranſit, aliter æquale ſpatio d a w — d a y; hac enim ratione curvæ K L, & K k L l non deſinent conditionem habere, quæ in regulâ priori requiritur, nempe ut ordinatæ ad æquales diſtantias a puncto M ſint æquales, & ab eâdem abſciſſæ parte poſitæ. Nam area hyperbolica a d w affirmativa eſt, quando d t vel P *v* eſt affirmativa, & eadem area negativa eſt, quando d t vel P*v* negativa eſt, quia area tota hyperbolica ab eâdem parte lineæ h q jacet; ideoque area curvarum K L, K *k* L *l* ad ordinatam M Π terminata ſignum ſuum mutabit, quando abſciſſa M P, magnitudine ſervatâ, ſignum mutat; & curvæ ordinata nec magnitudinem nec ſignum mutabit, mutatione ſigni abſciſſæ. Sit porro a d *q* = parallelogrammo Γ Ξ in hyperbolâ priori: quo efficietur ut t w + t v ſit ad a d ut Γ Σ ad Γ Λ (*a*); ſi igitur Γ Λ fiat = a d, erit t w + t v = Γ Σ = P Φ. Porro ducantur ordinatæ $\varepsilon n \zeta$, $\alpha\beta\gamma$ ordinatæ M Ψ proximæ; deinde in *Fig.* 2. ubi curva $\omega \Psi \Omega$ ſimplex eſt, cum εn ſit ad $\alpha\beta$ ut ſpatium M Ψ $\zeta\varepsilon$ ad ſpatium M Ψ $\gamma\alpha$, erit $\varepsilon n = \alpha\beta$; unde & earum utraque = M ε = M α. Ideoque εn ad $\frac{M\Psi\zeta\varepsilon}{M\Psi}$ ut radius ad ſinum anguli ſub N M Ψ, & ubique P I ad $\frac{M\Psi\Phi P}{M\Psi}$ in eâdem ratione. In *figurâ quartâ* ubi curva $\omega \downarrow \Psi \Omega$ ex duobus cruribus compoſita eſt, εn eſt ad $\alpha\beta$ ut ſpatium Ψ M $\varepsilon\zeta$ ad ſpatium $\downarrow$ M $\alpha\gamma$ ſive ut M Ψ ad M $\downarrow$, propterea quod M ε = eſt M α. Cum igitur neceſſe ſit, ut $\varepsilon n \times \alpha\beta$ = ſit M εq, ſcilicet ut crura M F, M E in angulo propoſito ſe mutuo interſecent, erit ratio εn ad M ε ſubduplicata rationis εn ad $\alpha\beta$ vel ſubduplicata rationis M Ψ ad M $\downarrow$:

(*a*) Vid. Philoſ. Tranſact. No. 338. prop. 4.

ideoque

ideoque $\epsilon\eta$ ad ſpatium $M\Psi\zeta\epsilon$ applicatum ad mediam proportionalem inter $M\Psi$, $M\downarrow$ ut radius ad ſinum anguli ſub $NM\Psi$; & generatim PI ad ſpatium $M\Psi\Phi P$ applicatum ad mediam proportionalem inter $M\Psi$ & $M\downarrow$ in eâdem ratione. Eſt autem $M\Psi = yx + dx$, & $M\downarrow = yx - dx$, & ad media eſt proportionalis inter $yx + dx$ & $yx - dx$. Unde utrobique dictis ad, a; dt vel $P\nu, R$; erit $P\Phi = \sqrt{aa + RR} + R$; $R = \frac{1}{2}a \times \sqrt{\frac{P\Phi}{a} - \frac{a}{\Phi P}}$;

& PI ad $\frac{MP\Phi\Psi}{a}$ ut radius ad ſinum anguli ſub $NM\Psi$.

Regula igitur *ſecunda pendet a primâ, & curvam problemati ſatisfacientem ſine ope ſpatii hyperbolici*, &c. ut ſupra. Nam hic ſine ſpatio hyperbolico curva invenitur, cujus quadraturâ problema ſolvitur.

Duæ autem ſunt in hac regulâ formulæ. Formula prior nimirum $P\Phi = \sqrt{aa + RR} + R$, curvarum geometrice rationalium, quæ maxime hic requiruntur, inventioni accommodatur; facile enim eſt ita ſumere quantitatem indeterminatam R, ut curva $\omega\Psi\Phi\Omega$ quadraturam admittat.

Ne caſus magis compoſiti memorentur, ponatur R vel $P\nu = cz^{\frac{m}{n}}$, ut m & n numeri ſint impares vel inter ſe primi, vel eorum alter unitas: hac enim ratione curva, cujus ordinata eſt $P\nu$, conditionem habebit in hac regulâ neceſſariam, & erit $P\Phi = \sqrt{aa + RR} + R = \sqrt{aa + cczz^{\frac{2m}{n}}} + cz^{\frac{m}{n}} = z^{\frac{m}{n}}\sqrt{cc + aaz^{\frac{-2m}{n}}} + cz^{\frac{m}{n}}$. Si igitur $\frac{m}{n} + 1$ ſit vel numero $\frac{-2m}{n}$ æqualis, vel ejuſdem multiplex, id eſt, ſi ſumatur $m = -1$,

— 1, & n numero cuilibet impari æqualis; pars ordinatæ $z^{\frac{m}{n}} \sqrt{cc + aa z^{\frac{-2m}{n}}} + c z^{\frac{m}{n}}$ ſub vinculo inclusa, ideoque & ordinata tota quadraturam admittet. (*a*)

Verbi causâ, ponatur $\frac{m}{n} = -\frac{1}{3}$, $c = 1$, & P Φ $= z^{-\frac{1}{3}} \sqrt{1 + aa z^{\frac{2}{3}}} + z^{-\frac{1}{3}}$. Unde erit area M Ψ Φ P $= \frac{\sqrt{1 + aa z^{\frac{2}{3}}}^{\frac{3}{2}}}{aa} + \frac{1}{2} z^{\frac{2}{3}}$, & P I $= \sqrt{\frac{1}{aa} + z^{\frac{2}{3}}}^{\frac{3}{2}} + \frac{3 z^{\frac{2}{3}}}{2a}$, curvaque quæſita hac æquatione comprehenditur $a \times$ P I $q - 3 z^{\frac{2}{3}} \times$ P I $= \frac{1}{a^5} + \frac{3 z^{\frac{2}{3}}}{a^3} + \frac{3 z^{\frac{4}{3}}}{4a} + a z^2$. In hac æquatione cum $z^{\frac{2}{3}}$ ſignum non mutabit, mutatione ſigni abſciſſæ z; pro eâdem ipſius magnitudine tam negativâ quam affirmativâ P I eandem habebit magnitudinem, & ſub eodem ſigno; unicuique autem magnitudini abſciſſæ z reſpondet & affirmativa & negativa ordinata: adeo ut curva quæſita habebit formam hic appoſitam (in *Fig.* 6.); e tribus conſtans cruribus a b c, d e, d f punctis b, d æqualiter a puncto M diſtantibus; quippe eſt M d = M b = $\frac{1}{a^3}$: quando enim eſt $z = 0$, erit P I $q = \frac{1}{a^6}$; & P I = $\pm \frac{1}{a^3}$.

(*a*) Vid. in Tract. de quadr. curv. Newton. tab. curv. ſimplicior. quæ quadrari poſſunt.

Hæc

Hæc autem regulæ hujus formula prior ſecundum exhibet curvas quæſitas inveniendi modum.

In formulâ poſteriori, cum R ſit $= \frac{1}{2} a \times \sqrt{\frac{P\Phi}{a} - \frac{a}{P\Phi}}$, R vel P ν ejuſdem magnitudinis manebit, ſed ſignum mutabit, quando abſciſſa magnitudinem ſuam ſigno mutato retinet, ſi P Φ talis ſumatur, ut mutando abſciſſæ ſignum $\frac{P\Phi}{a}$ convertatur in $\frac{a}{P\Phi}$, & contra ut $\frac{a}{P\Phi}$ convertatur in $\frac{P\Phi}{a}$. Et hæc formula poſterior tertium continet problema ſolvendi modum.

Verbi causâ, fit $P\Phi = a \times \frac{c - z}{c + z}$, quando z eſt affirmativa, & erit R vel P ν eodem tempore $= \frac{1}{2} a \times \sqrt{\frac{c - z}{c + z} \cdot \frac{c + z}{c - z}}$, quando autem z negativa eſt, fiet $P\Phi = a \times \frac{c + z}{c - z}$, & R vel Q $\rho = \frac{1}{2} a \times \sqrt{\frac{c + z}{c - z} \cdot \frac{c - z}{c + z}}$. Hinc autem R æqualis erit $\frac{\mp 2acz}{cc - zz}$, & R $zz \mp 2acz = xc$ R; ideoque curva x M μ linea tertii ordinis, imo ſpecies earum quinquageſima nona; propterea quod æquationis cc R R $+ aacc = 0$ radices ſunt impoſſibiles (*a*). Linea autem curva hinc invenienda, ſi fiat (in *Fig.* 7.) N M vel M O $= c$, logarithmica eſt, cui recta A B eſt aſymptotos. Cum

(*a*) Vid. Newton. Enumerat. linear. tert. ordin. ad Fig. 63.

enim P Φ fit $= a \times \frac{c - z}{c + z}$, erit eadem $= \frac{ac}{c+z} - \frac{az}{c+z}$. Si igitur (in *Fig.* 8.) in rectâ lineâ quacunque $\alpha\varepsilon$ fumatur $\alpha x = O M = c$, & ei ad perpendiculum erigantur $\alpha\beta$, $x\mu$ quarum $x\mu$ fit $= a$, & fi afymptotis $\alpha\varepsilon$, $\alpha\beta$ per punctum μ defcribatur hyperbola $\zeta\eta$, & fumptâ $x\nu = M P = z$, ducatur $\nu\rho$ afymptoto $\alpha\beta$ parallela; parti $\frac{ac}{c+z}$ ordinatæ P Φ refpondet area, quæ erit ad aream $x\mu\rho\nu$ ut finus anguli fub N P I ad radium, & alteri parti $\frac{az}{c+z}$ ejufdem ordinatæ refpondet area, quæ erit ad $a \times x\nu - x\mu\rho\nu$ in eâdem ratione (*a*). Unde P I, quæ eft ad $\frac{M P \Phi \Psi}{a}$ ut radius ad finum anguli fub N M Ψ, erit $= \frac{2x\mu\rho\nu}{a} - x\nu$. Si igitur fumatur $O\varsigma = O M$, & ducatur ς M ordinatæ P I retro productæ occurrens in χ, ut fit $P\chi = P M = x\nu$, erit $\chi I = \frac{2x\mu\rho\nu}{a}$: ideoque linea M I logarithmica, cui A B afymptotos eft, & ς M ordinatim applicata, efficiens cum afymptoto A B angulum fub A ς M verfus contingentem æqualem dimidio anguli fub A O N. *Alter igitur hujus lineæ caſus deducitur*, &c. ut fupra.

Magis generatim, fi r ordinatam curvæ alicujus denotat, quæ inftar curvarum $x M \mu$, & $x n c$, $m p \mu$ ad abfciffam N O defcripta ordinatas habeat æquales, quæ

(*a*) Vid. Newton. de quadr. curv. tab. curv. fimpl. quæ cum circ. & hyperb. compar. poffunt, form. prim.

æqualiter

æqualiter diſtant a puncto M, ſed a contrariis partibus abſciſſæ poſitas, poni poteſt ordinata $P\Phi = a\,x$

$$\sqrt[\pi]{\frac{\overline{b \mp cr + drr \mp e r^3 + \&c}\ \times \overline{f \mp gr + \&c}^{\lambda}\ \times \overline{h \mp kr + lrr \mp \&c}^{\mu}}{\overline{b \pm cr + drr \pm e r^3 + \&c}\ \times \overline{f \pm gr + \&c}^{\lambda}\ \times \overline{h \pm kr + lrr \pm \&c}^{\mu}}}^{\nu}$$

Ex priori hujus regulæ ſecundæ formulâ deducitur quoque theorema, cujus ſupra fit mentio, ad inveniendas curvas tam rationales quam irrationales utile, quod quartus erit modus problema ſolvendi.

Theorema.

Quoniam eſt $P\Phi = \sqrt{aa + RR} + R$, & $R = P\nu$, manifeſtum eſt, ſi $\frac{R}{a}$ vel $\frac{P\nu}{a}$ ſit ut fluxio ordinatæ, quæ abſciſſæ ſuæ ad perpendiculum inſiſtat, alicujus curvæ, erit $\frac{\sqrt{aa + RR}}{a}$, ut ejuſdem curvæ fluxio; curvæ autem hujus ordinata æqualis erit areæ curvæ $x\mu$ ad a applicatæ, ſi angulus ſub M P ν rectus ſit, & cum area curvarum (in *Fig*, 2, 4.) x M μ, & x n c, m p μ eodem ſigno afficiatur, tam quando abſciſſa eſt affirmativa, quam quando eſt eadem negativa, quoniam areæ ad diverſas abſciſſæ partes in illis diverſis caſibus jacent; & præterea cum eiſdem abſciſſæ magnitudinibus areæ æquales reſpondeant, curvæ, quales problema requirit, inveniri poſſunt curvarum ope, quarum ordinatæ ad eaſdem abſciſſæ magnitudines æquales ſint, & ab eâdem abſciſſæ parte poſitæ, ſi modo ordinatæ inſiſtunt abſciſſæ ad perpendiculum.

Deſcripta ſit ejuſmodi curva n o, quæ tangat abſciſſam in puncto M (ut in *Fig*. 9.) ſi evaneſcat, quando abſciſſa eſt $= o$, fluens quantitas fluxioni longitudinis curvæ n o reſpondens; aliter, quæ habeat ordinatam primam M m (ut in *Fig*. 10.) æqualem magnitudini

fluentis istius quantitatis, quando abscissa est = o. Erigantur ordinatæ P p, Q q; deinde erit P I curvæ quæsitæ ordinata, quæ ab alterâ parte puncti M jacet, vel = M p + P p, vel = M m p + P p; ordinata autem Q R, quæ ab alterâ parte puncti M cadit, vel = M q — Q q, vel = M m q — Q q.

Observandum autem est hoc theorema aliquando partem duntaxat curvæ quæsitæ describere.

Ex ratione autem, qua hoc theorema investigatur, manifestum est duo crura curvæ hic descriptæ ejusdem lineæ esse partes: nimirum utriusque naturam eâdem æquatione definiri. Hanc autem curvam in situ inverso dispositam se intersecare in angulo æquali angulo sub N O B inde manifestum est, quod rectangulum sub fluxione P I & sub fluxione Q R, ordinatarum scilicet æqualiter a puncto M distantium, æquale est quadrato fluxionis abscissæ: si enim curvæ n o ordinatæ w r, x t applicentur ordinatis Q q, P p proximæ, & P x, Q w sint æquales, & ducantur r s, t v abscissæ N O parallelæ, erunt triangula p t v, q r s rectangula similia & æqualia: *in omni* autem *triangulo rectangulo quadratum ab alterutro latere angulo recto adjacenti æquale est rectangulo sub summâ alterius lateris angulo recto adjacentis lateriſque angulo ei subtendentis, & sub differentiâ eorundem laterum.* Igitur $\overline{tv}^2 = \overline{Px}^2 = \overline{pt+pv} \times \overline{pt-pv} = \overline{pt+pv} \times \overline{qr-qs}$: est autem ultima ratio P x ad p t + p v ea, quam fluxio abscissæ habet ad fluxionem ordinatæ P I; & ratio P x vel Q w ad q r — q s ea, quam fluxio abscissæ habet ad ordinatæ Q R fluxionem. Unde constat propositum. *Regula* igitur *secunda theorema*, &c. ut supra.

Jam si n o sit circuli circumferentia, linea E F cyclois erit, quando angulus sub N O B vel sub N P I rectus est. Porro si curvæ n o longitudo cum rectâ conferri potest, quarum curvarum simplicissima est parabola semicubica,

curva

curva inventa rationalis erit. Speciatim parabola ſemicubica, ſi rite diſponatur, ejus curvæ partem dimidiam exhibebit, quam in exemplum formulæ prioris regulæ ſecundæ delineavimus; ſcilicet (in *Fig.* 6.) crus d e, partemque inferiorem b c cruris a b c. Reliquæ autem illius partes deſcribi poſſunt, ſi retro producatur ordinata I P donec pars producta æqualis ſit M m p — P p, & producatur R Q ab altero abſciſſæ latere, donec pars producta æqualis ſit M m q + Q q.

Nunc tranſeundum eſt ad regulam tertiam, quæ etiam curvas geometrice rationales largitur.

Regula Tertia.

Regula hæc tertia duos quoque complectitur problema ſolvendi modos a prioris regulæ formulis propoſitione nonâ tractatus de quadraturâ curvarum *Newtoni* derivatos.

Propoſitione iſtâ ad formulam regulæ præcedentis priorem adhibitâ invenitur area curvæ, cujus abſciſſa eſt z, & ordinata $\sqrt{aa+RR}+R$, æqualis areæ curvæ, cujus abſciſſa eſt R & ordinata $\frac{\dot{z}}{\dot{R}}\sqrt{aa+RR}$ $+\frac{\dot{z}}{\dot{R}}$ R. Hinc autem quinto modo ſolvitur problema.

Verbi causâ, ut exemplum generale, quod antea (*a*) exhibui, inveſtigetur, poſitis M P $=z$, & P $v=$ R, ut prius, fiat $\frac{\dot{z}}{\dot{R}}=R^{\frac{m-n}{n}}\times\sqrt{c+dR^2}$, & erit $z=R^{\frac{m}{n}}$

(*a*) In Act. Erud. Menſ. April. 1721.

$\times \frac{n}{m} c + \frac{n}{m+2n} d R^2$; ſint autem m & n numeri impares vel inter ſe primi vel eorum alter unitas; ut ſigna abſciſſæ z & ordinatæ R ſimul mutentur, ſicut in regulâ priori requiritur; jam erit ordinata $\frac{z}{R}\sqrt{aa+RR}$ $+\frac{\dot{z}}{\dot{R}} R = R^{\frac{m-n}{n}} \times \overline{c+dR^2} \times \sqrt{aa+RR} + R^{\frac{m}{n}}$ $\times \overline{c+dR^2}$; area igitur curvæ, cujus abſciſſa eſt z & ordinata $\sqrt{aa+RR}+R$, æqualis erit areæ curvæ, cujus abſciſſa eſt R & ordinata $R^{\frac{m-n}{n}} \times \overline{c+dR^2} \times \sqrt{aa+RR} + R^{\frac{m}{n}} \times \overline{c+dR^2}$, ſi modo hæc poſterior ordinata cum abſciſsâ ſuâ angulum contineat æqualem angulo ſub NMΨ; unde hujus poſterioris curvæ quadraturâ linea exhibetur problemati ſatisfaciens. Erit autem hæc linea curva geometrice irrationalis, niſi m & n certos quoſdam numeros deſignant, vel certa quædam ſit relatio inter coefficientes c, d; hæ autem conditiones ratione ſequenti inveniuntur. Erit (a) area curvæ, cujus abſciſſa R & ordinata $R^{\frac{m}{n}} \times \overline{c+dR^2} + R^{\frac{m-n}{n}} \times \overline{c+dR^2} \times \sqrt{aa+RR}$, ad $R^{\frac{m+n}{n}} \times \frac{n}{m+n} c + \frac{n}{m+3n} d R^2 + R^{\frac{m}{n}} \times \overline{aa+RR}^{\frac{3}{2}}$

$$\times \frac{n}{maa} c + \frac{d - \frac{m+3n}{maa} \times c}{\frac{m+2n}{n} aa} R^2 + \text{&c.}$$

ut ſinus an-

(a) Per prop. quint. quadr. curv. Newton.

guli

guli ſub NMΨ ad radium. Hæc autem ſeries terminabitur, & quadraturam finitam dabit, ſi n ſit unitas & m numerus negativus ternario major, vel ſi ultimus terminorum hic ſcriptorum ſit nihilo æqualis, id eſt, ſi ſit $d = \frac{m+3n}{maa}c$, vel ſi ſit $d = 0$, $n = 1$, & $m = -3$. Et hic quidem ultimus caſus curvam exhibet, quæ theoremate præcedenti a parabolâ ſemicubicâ invenitur.

Magis generatim ponere licet $\frac{z}{R} = R^{\frac{m-n}{n}} \times \overline{c + dR^2 + eR^4 + \&c \ldots . + fR^p}$, ubi p numerum quemcunque parem denotat; unde fiat $z = R^{\frac{m}{n}} \times \overline{\frac{n}{m+2n}dR^2 + \frac{n}{m+4n}eR^4 \ldots . + \frac{n}{m+pn}fR^p}$, & curvæ $\omega\Omega$ ordinata $= R^{\frac{m-n}{n}} \times \overline{c + dR^2 + eR^4 \ldots . + fR^p} \times \sqrt{aa + RR} + R$. Hinc (*a*) ſi n ſit unitas & m numerus negativus numero $p + 1$ major, curva dabitur geometrice rationalis, vel ſi certa quædam relatio ſit inter coefficientes $c, d, e, \&c \ldots . f$, quæ relatio facile invenitur ut antea.

Porro ad alteram regulæ ſecundæ formulam adhibendo propoſitionem nonam memoratam libri de quadraturâ curvarum, ſextus oritur problema ſolvendi modus.

Literâ r denotante ut ſupra, fieri poteſt ordinata $P\Phi = a \times \frac{b + cr + drr + \&c}{b - cr + drr - \&c}$, area curvæ, cujus abſciſſa eſt z & ordinata $P\Phi$, æqualis erit areæ curvæ,

(*a*) Per prop. proxim. citat.

cujus

cujus abſciſſa eſt r & ordinata $a \times \frac{\dot{z}}{\dot{r}} \times \frac{b+cr+drr+\&c}{b-cr+drr-\&c}$

Ponatur igitur $\frac{\dot{z}}{\dot{r}} = r^{\frac{m-n}{n}} \times \overline{b+cr+drr+\&c} \times \overline{b-cr+drr-\&c}^{p} = r^{\frac{m-n}{n}} \times \overline{bb+2bd-cc} \times \overline{rr+ddr^4+\&c}^{p}$, & curva, cujus ordinata eſt r conditionem hic neceſſariam habebit. Erit enim $z = r^{\frac{m}{n}} \times \overline{bb+2bd-cc} \times \overline{rr+ddr^4+\&c}^{p+1} \times \overline{A+Brr+Cr^4+\&c}$, cujus ſeriei coefficientes A, B, C &c dantur per propoſitionem quintam Tractatus de Quadraturâ Curvarum. Manifeſtum autem eſt nec terminos hujus ſeriei nec quantitatem $\overline{bb+2bd-cc} \times \overline{rr+ddr^4+\&c}^{p+1}$ ſigna ſua mutare mutatione ſigni quantitatis r; quantitas autem $r^{\frac{m}{n}}$, ſi m, n numeri ſint impares, ſignum mutabit, quando ipſa r ſignum mutat; ideoque ordinata r & abſciſſa z ſigna ſimul mutabunt.

Ordinata autem $a \times \frac{\dot{z}}{\dot{r}} \times \frac{b+cr+drr+\&c}{b-cr+drr-\&c} =$ erit $ar^{\frac{m-n}{n}} \times \overline{bb+2bd-cc} \times \overline{rr+ddr^4+\&c}^{p-1} \times \overline{b+cr+drr+\&c}^{2}$. Et hinc facile inveniri poſſunt curvæ rationales.

Pro exemplo ſimplici ponatur $p = 1 = m = n$, d, $\&c = 0$; unde erit $\frac{\dot{z}}{\dot{r}} = bb - ccrr$, & $z = bbr - \frac{1}{3}ccr^3$. Ordinata autem curvæ metiendæ $= abb + 2abcr + accrr$; ejuſdem igitur area eſt ad $abbr + abcrr + \frac{1}{3}accr^3$ ut ſinus anguli ſub NM Ψ ad radium; ideoque erit P I $= bbr + bcrr + \frac{1}{3}$

$+\frac{1}{3}ccr^3$. Hinc autem invenitur parabolam ſemicubicam problemati ſatisfacere, quam ita deſcribere oportet. Datâ (in *Fig.* 11.) lineâ rectâ A B, & in eâ puncto C, una cum lineâ rectâ C D angulum ſub B C D cum lineâ C B conſtituente æqualem angulo, in quo curva ſe interſecare requiritur. Ducatur ad libitum H G I ad C D parallela, ſumaturque in eâ G H = 2 C G; deinde dividatur angulus ſub A C D in duas partes æquales lineâ rectâ C E, & denique ad diametrum H I & verticem H deſcribatur parabola ſemicubica K H L, quæ tranſeat per punctum C, ita ut C E ordinatim applicetur ad diametrum H I. Hæc parabola ad eandem lineam ſimiliter applicata, ſed ſitu inverſo, ſe interſecabit in angulo æquali angulo ſub B C D.

Si placet curvas hac regulâ inventas theoremate præcedente conſtruere, ex iis, quæ hic tradita ſunt, curva huic negotio apta inveniri poteſt; erit enim curvæ illius ordinata æqualis areæ curvæ $x\mu$ ad a applicatæ, quando angulus ſub M P v rectus eſt. Verbi causâ, hujus areæ fluxio, nimirum P $v \times \dot{z}$ in exemplo ſecundo prioris partis hujus regulæ erit $= \dot{R}\,\overline{R \times R^{\frac{m-n}{n}} \times c + dR^2 + eR^4 \ldots + fR^p}$ $= \dot{R}\,R^{\frac{m}{n}} \times \overline{c + dR^2 + eR^4 \ldots + fR^p}$; ideoque curvæ hic requiſitæ ordinata erit $= \frac{1}{a} R^{\frac{m+n}{n}} \times \overline{\frac{n}{m+n} c + \frac{n}{m+3n} dR^2 + \frac{n}{m+5n} eR^4 \ldots + \frac{n}{m+p+1 \times n} fR^p}$.

In exemplo poſterioris partis hujus regulæ erit $R\left(= \frac{1}{2}a \times \overline{\frac{P\Phi}{a} - \frac{a}{P\Phi}}\right) = \frac{2bcr + 2cdr^3 + \&c}{\overline{bb + 2bd - cc} \times rr + ddr^4 + \&c}$;

ideoque $R \times \dot{z} = \dot{r} r^{\frac{m}{n}} \times \overline{2bc + 2cdr^2 + \&c} \times \overline{bb + 2bd - cc \times rr + ddr^4 + \&c}^{p-1}$; hæc igitur eſt fluxio ordinatæ curvæ quæſitæ.

Si ſit $m = 1 = n = p$, d, $\&c = 0$, erit $R \times \dot{z} = 2bcr\dot{r}$, & ordinata curvæ quæſitæ $= bcrr$; quoniam igitur $z =$ erit $bbr - \frac{1}{3}ccr^3$, erit curva quæſita in hoc caſu parabola divergens cum nodo, quæ definitur hac æquatione $3ezz = y^3 - 2eyy + eey$ (*a*). Et hac curvâ deſcribetur parabola ſemicubica ſupra inventa.

Verbi causâ, ad rectam lineam (in *Fig.* 12.) A B ducatur perpendicularis C D, & ad illam ut axim deſcribatur ejuſmodi parabola divergens F E C E G. Deinde ducatur ad libitum H I angulum quemcunque datum cum rectâ A B conſtituens, & ducatur H K L M ad C D parallela; deinde ſumatur H N = H K + arc. C K, H O = H L + arc. C K L, & ab alterâ parte puncti H, H P = C E M — H M; & curva hac ratione deſcripta parabola ſemicubica erit.

Hinc apparet quomodo curvæ, quarum inveſtigationi regula hæc tertia aptatur, theoremate præcedenti conſtrui poſſunt, poſtquam earum formæ cognoſcuntur, ſed hæ curvarum formæ, a quibus rationales deriventur, regulâ hac tertiâ optime inveniuntur.

Hæ ſunt tres regulæ, quarum ſupra fit mentio. Ultima ſententia, quæ ſub notis fictis celata fuit, exemplo ſequenti illuſtrari poteſt. Sit y vel $= a + bx + \sqrt{c + 2dx + ex^2}$ vel $= \frac{a + bx + cxx}{d + ex}$, quæ

(*a*) Vid. Enumerat. linear. tert. ord. Fig. 73.

duæ æquationes omnes complectuntur sectiones conicas. Inde vero inveniemus $\frac{\ddot{y}}{\dot{y}}$ vel $= \frac{ec}{d+ex} - \frac{dd}{\sqrt{c+2dx+exx} \times c+2dx+exx}\dot{z}$, vel $= \frac{2cdd+2aee-2bde}{\sqrt{d+ex} \times bd-ae+2cdx+cexx}\dot{z}$; quæ æquationes ostendunt in nullâ sectione conicâ, quomodocunque disponatur, quantitatem $\frac{\ddot{y}}{\dot{y}}$ conditionem habere, quam hoc problema requirit; ideoque nullam sectionem conicam problemati satisfacere. Quod comprobari etiam potest examinando rectangulum sub fluxionibus primis ordinatarum æqualiter ad diversas partes a principio abscissæ distantium.

Hinc autem cognoscitur nullam lineam curvam geometrice rationalem problema solvere, quæ parabolâ semicubicâ sit simplicior.

Si vero talis inter quantitates a, b, c, d, e relatio statui potuisset ut $\frac{\ddot{y}}{\dot{y}}$ conditionem in hoc problemate necessariam obtineret, nempe ut quantitas, quæ in $\dot{z}$ ducitur, eadem esse potuisset, & sub eodem signo, pro eâdem magnitudine tam negativâ quam affirmativâ abscissæ z, quo eveniret ut $\frac{\ddot{y}}{\dot{y}}$ foret $= -\frac{\ddot{v}}{\dot{v}}$, si abscissa in oppositas partes a suo principio, æqualibusque momentis fluere ponitur: tum profecto sectio conica hinc determinanda vel problema solveret, vel sectionis proble-

problemati ſatisfacientis ordinata ad ordinatam hujus rationem haberet datam.

Jam vero his regulis alias aliquot, quas ab amico accepi, ad problema ſolvendum adjungam.

Regula Quarta.

Iiſdem poſitis ac in regulâ primâ, ſit (in *Fig.* 13.) N O ad A B, C D perpendicularis ; ſint P I, Q R ordinatæ æqualiter a puncto M diſtantes, & ſit curva G H per punctum I ducta ſimilis & æqualis curvæ f E F. Ordinatis P I, Q R parallelæ & proximæ ducantur π j l, δ r, & lineæ rectæ I k, R s lineæ N O parallelæ. Angulus ſub s R r = eſt angulo ſub k I l ; unde anguli ſub j I k, s R r ſimul ſumpti æquales ſunt angulo dato ſub j I l ; & quantum angulus ſub j I k dimidium anguli ſub j I l ſuperat, tantum angulus ſub s R r ab eodem dimidio deficit. Si igitur (in *Fig.* 14.) radio quolibet m n circuli arcus n o deſcribatur, & ſumatur angulus ſub n m p = dimidio anguli dati ſub j I l, angulus ſub n m q = angulo ſub j I k, & angulus ſub n m t = ei ſub s R r, ſectores q m p, p m t erunt æquales. Poſitâ autem I k = R s = 1, erit j k ut tangens anguli ſub j I k vel anguli ſub n m q, & r s erit ut tangens anguli ſub s R r vel anguli ſub n m t ; ideoque & fluxio ordinatæ P I erit ut tangens anguli ſub n m q, nimirum ut n v ; & fluxio ordinatæ Q R ut tangens anguli ſub n m t, nimirum ut n w ; curvæ igitur Ψ Φ Ω, cujus areæ ordinata P I proportionalis eſt, ordinata P Φ poteſt eſſe æqualis tangenti n v, & ordinata Q χ ab alterâ parte puncti M = n w. Quoniam autem ſectores p m q, p m t ſunt æquales, conſtitui poteſt ſector p m q æqualis areæ M Π W P curvæ cujuſcunque K L conditionem habentis in regulâ primâ indicatam ; & ſector p m t æqualis areæ M Π X Q ejuſdem curvæ. Denique

que ſi ducatur linea recta $\varepsilon n \zeta$ lineæ $M\Psi$ parallela & proxima; cum angulus ſub $\varepsilon M n =$ ſit dimidio anguli ſub j I l, vel angulo ſub n m z, erunt triangula $\varepsilon M n$, n m z ſimilia, & prima ratio εn ad εM eadem cum ratione z n ad n m; ideoque $\varepsilon n = \frac{M\Psi\zeta\varepsilon}{nm}$, propterea quod $\varepsilon M =$ eſt $\frac{M\Psi\zeta\varepsilon}{M\Psi}$, & $M\Psi =$ n z. Hic autem habetur ſeptimus modus, quo problema ſolvi poteſt.

Si loco curvæ K L linea recta ſumatur, quicunque ſit angulus ſub n m z eadem deſcribetur curva; adeo ut hac ratione invenitur una eademque curva, quæ diverſis ſitibus in angulo quocunque dato problema ſolvit. Hæc autem curva a circuli & hyperbolæ quadraturâ dependet; ſi enim ducantur $m\tau$, $n\sigma$ ad m n perpendiculares, quarum $n\sigma =$ ſit m n, & aſymptotis m n, $m\tau$ hyperbola $\omega\sigma\downarrow$ deſcribatur, & deinde q $\varphi\nu$, p $\theta\varsigma$ ducantur lineis $m\tau$, n σ parallelæ; quando M P = eſt arcui circuli p q, erit ordinata P I = $\frac{\theta\varphi\upsilon\varsigma}{mn}$, ſi m n = ſit 2 M Π (*a*).

Regula Quinta.

Deſcribatur (in *Fig.* 13.) curva $\varkappa M \mu$ ut in regulâ ſecundâ, & (in *Fig.* 15.) radio = m n deſcribatur ſemicirculus $\alpha\beta\gamma$, cujus centrum δ, ſit autem $\delta\beta$ diametro $\alpha\gamma$ perpendicularis. Sumatur $\delta\varepsilon =$ P ν, ducatur $\varepsilon\zeta$ ad $\delta\beta$ parallela, jungaturque $\delta\zeta$. Deinde ſit curva K L ejus naturæ, ut area M Π W P ſemper æqualis ſit ſectori $\beta\delta\zeta$. In circuli arcu (*Fig.* 14.) n o du-

(*a*) Vid. Barrov. lect. geometr. pag. 110.

ctis

ctis p_n ſinu arcus p q, & $p\theta$ ſinu arcus n p, producatur m p ad z, ducaturque $z\xi$ ad p_n parallela. Porro dictis m n = m p, a; m θ, b; n z, c; p_n, R; n v, y; erit ut m p : p_n :: m z : $z\xi$, ſed ut m θ : m n (m p) :: m n : m z; ex æquo igitur ut m θ (b) : p_n(R) :: m n : $z\xi$ :: m v ($\sqrt{aa+yy}$) : z v ($y-c$) unde $by-bc = R\sqrt{aa+yy}$, & denique y = n v = P Φ = $\frac{bbc+aR\sqrt{aa-RR}}{bb-RR}$.

Hinc autem modo octavo ſolvitur problema.

Regula Sexta.

Per propoſitionem nonam Tractatus de Quadraturâ Curvarum area curvæ, cujus abſciſſa eſt z & ordinata $\frac{bbc+aR\sqrt{aa-RR}}{bb-RR}$, æqualis eſt areæ curvæ, cujus abſciſſa eſt R & ordinata $\frac{\dot{z}}{\dot{R}} \times \frac{bbc+aR\sqrt{aa-RR}}{bb-RR}$.

Unde habetur modus nonus problema ſolvendi.

Literæ m & n eadem denotent, ac in regulâ tertiâ, & fiat $\frac{\dot{z}}{\dot{R}} = R^{\frac{m-n}{n}} \times \overline{bb-RR}^{p}$, & ordinata $\frac{\dot{z}}{\dot{R}} \times \frac{bbc+aR\sqrt{aa-RR}}{bb-RR}$ fiet $= bbcR^{\frac{m-n}{n}} \times \overline{bb-RR}^{p-1} + aR^{\frac{m}{n}} \times \overline{bb-RR}^{p-1} \times \sqrt{aa-RR}$.

Unde ſi n unitatem deñotet, & p numerum quemcunque integrum & affirmativum, curva geometrice rationalis invenietur.

Regula

Regula Septima.

Ducatur (in *Fig.* 15.) $\beta\lambda$ ſemicirculum $\alpha\beta\gamma$ contingens in β, & producatur $\varepsilon\zeta$ ad μ, ductâ $\delta\nu\mu$. Sit autem curva (in *Fig.* 13.) K L ejus naturæ, ut area M Π W P = ſit ſectori $\delta\beta\nu$. Dictis igitur m n, a; n z, c; & tangente arcus p q, R; erit n v = P Φ = $\frac{aac+aaR}{aa-cR}$. Et hic eſt decimus problema ſolvendi modus.

Quando angulus interſectionis rectus eſt, & $c = a$, hæc regula ſub formulâ poſteriori regulæ ſecundæ comprehenditur.

Item ſi loco x M μ linea recta ſumatur, quicunque ſit interſectionis angulus, caſus ille curvæ logarithmicæ invenietur, quem in regulâ ſecundâ tradidimus.

Regula Octava.

Ut antea, eſt area curvæ, cujus abſciſſa z & ordinata $\frac{aac+aaR}{aa-cR}$, æqualis areæ curvæ, cujus abſciſſa eſt R & ordinata $\frac{\dot{z}}{\dot{R}} \times \frac{aac+aaR}{aa-cR}$. Hic autem eſt undecimus modus problema exequendi.

Literis m, n iiſdem denotantibus, ut antea, ſit $\frac{\dot{z}}{\dot{R}} = R^{\frac{m-n}{n}} \times \overline{a^4 - cc\,R\,R}^{p}$; & ordinata $\frac{\dot{z}}{\dot{R}} \times \frac{aac+aaR}{aa-cR}$ fiet = $R^{\frac{m-n}{n}} \times \overline{a^4 c + \overline{a^4 + a^2 cc} \times R + aacRR}$ $\times a^4 -$

$\times a^{+} - cc\,\mathrm{R}\,\mathrm{R}\Big)^{p-1}$: quæ formula curvas geometrice rationales facile præbet.

Si ſit $m = 1 = n = p$; eadem parabola ſemicubica atque ex regulâ tertiâ invenietur.

Regula nona.

Si (in *Fig.* 16.) NO ad lineas AB, CD perpendicularis ſit, & ducatur curva KL, cujus ordinatæ PW, QX, quæ æqualiter a puncto M diſtant, æquales ſint, & ab eâdem abſciſſæ parte poſitæ; radio ordinatæ PW æquali deſcribatur circuli ſegmentum abc, quæ angulum comprehendat angulo æqualem, in quo curva ſe ipſam ſecare requiritur. Ducatur autem & alia curva $\varkappa$Mμ cujus ordinatæ Pν, Qρ æqualiter a puncto M diſtantes ſint æquales & a contrariis partibus abſciſſæ NO poſitæ. Deinde ſumptâ Mf = Pν ductâque fh lineæ NO ad perpendiculum, junctâque ch, manifeſtum eſt, ſi curva quæſita EF ejus ſit naturæ, ut contingens in puncto I ſemper ſit parallela lineæ ch, propoſito ſatisfaciet. Nam cum ſit WP = QX, idem circuli ſegmentum ordinatis PW, QX convenit ; adeo ut ſi ſumatur Mg = Qρ, ducatur gk ad NO perpendicularis, & jungatur ck, linea recta contingens curvam quæſitam EF in puncto R parallela erit lineæ ck. Quoniam igitur Qρ = eſt Pr, ideoque Mg = Mf in ſitu hujus curvæ EF inverſo, & quando punctum R in punctum I cadit, contingens in puncto R lineæ puncta a, h conjungenti parallela erit, & cum contingente in puncto I angulum conſtituet æqualem ei ſub ahc, nimirum angulo in ſegmento abc comprehenſo. Invenitur igitur hujuſmodi curva, ſi fiat ut $\dot{y} : \dot{z} :: fh : fc$. Quamobrem ſi pro PW ponatur m ; pro aM = Mc

= M c ponatur n; pro intervallo inter punctum M & centrum ſegmenti ponatur p; & pro P y = M q; habebimus $y : z :: \sqrt{mm - qq} \pm p : n + q$, & $y = \frac{\sqrt{mm - qq} \pm p}{n + q} z$. Dantur autem rationes inter m, n, p ob datum ſegmenti a b c angulum, & invenietur y vel P I metiendo curvam, cujus abſciſſa eſt z & ordinata $\frac{\sqrt{mm - qq} \pm p}{n + q}$. Hic autem exhibetur duodecimus modus problema tractandi.

Si angulus ſub a h c ſit rectus, erit $p = 0$, $n = m$, & ordinata curvæ metiendæ $\sqrt{\frac{m - q}{m + q}}$. Quam profecto ordinatam problemati ſatisfacere, intelligi quoque poteſt ex poſteriori regulæ ſecundæ formulâ.

Si loco linearum curvarum K L, κ M μ rectæ ſumantur, quando angulus ſub a h c rectus eſt, erit curva E F cyclois; quæ facile determinatur formâ undecimâ tabulæ curvarum ſimpliciorum, quæ cum circulo & hyperbolâ comparari poſſunt in Tractatu de Quadraturâ Curvarum *Newtoni*.

Regula Decima.

Porro area curvæ, cujus abſciſſa eſt z & ordinata $\frac{\sqrt{mm - qq} \pm p}{n + q}$, æqualis eſt tum areæ curvæ, cujus abſciſſa eſt m & ordinata $\frac{\dot{z}}{m} \times \frac{\sqrt{mm - qq} \pm p}{n + q}$; tum areæ curvæ, cujus abſciſſa eſt q & ordinata $\frac{\dot{z}}{q} \times \frac{\sqrt{mm - qq} \pm p}{n + q}$. Unde habentur duo alii mo-

di, quibus problema ſolvi poteſt ; quorum poſteriori, ratione ſequenti, curvæ geometrice rationales inveniri poſſunt.

Sint δ, ε numeri impares, n numerus par, & ponatur $\frac{z}{q} = q^{\frac{\delta - \varepsilon}{\varepsilon}} \times \overline{n^n - q^n}$, item $m = 1 + \frac{1}{4} q q$. Unde erit $z =$ areæ curvæ, cujus abſciſſa eſt q & ordinata $q^{\frac{\delta - \varepsilon}{\varepsilon}} \times \overline{n^n - q^n}$, & ordinata $\frac{z}{q} \times \frac{\sqrt{m m - q q} \pm p}{n + q}$ fiet $= \frac{n^{n-1} - n^{n-2} q + n^{n-3} q q + \&c \ldots . - q^{n-1}}{\times 1 - \frac{1}{4} q q} \pm p$.

His quatuordecim diverſis modis generalibus amicus meus problematis ſolutionem abſolvit. Demonſtrationes autem illius ex compoſitione uſus in hoc problemate curvarum Geometris notarum ſic ſe habent.

De Caſu primo Linearum logarithmicarum.

Sit (in *Fig.* 17.) A B linea logarithmica aſymptoton habens C D ; eique ordinatim applicetur E F, quæ ſit ſubtangenti logarithmicæ æqualis. Ad lineam rectam E F & ad quodcunque in eâ punctum I conſtituatur alia linea logarithmica G H I priori ſimilis & æqualis, ſed ſitu inverſo diſpoſita. Deinde ſi contingentes H L, H M ducantur, dico angulum ſub L H M angulo ſub C E F eſſe æqualem.

Ordinatim applicetur H N, fiat E O = E N, ordinatim applicetur O P, & ducatur contingens P Q. Puncta P & H æqualiter diſtant a rectâ E I, unde punctum P in curvâ A B puncto H in curvâ G I reſpondet, & angulus ſub O P Q = eſt angulo ſub N H M, propterea quod curvæ A B, G I ſimiles ſunt & æquales. Quoniam vero curva A B eſt logarithmica

mica & E N, E O æquales, erit N H x O P = E F q. Eſt autem E F = N L = O Q, unde ut N H : E F (N L) : : E F (O Q) : O P. Cum igitur anguli ſub H N L, Q O P ſint æquales, triangula H N L, Q O P ſunt ſimilia, & angulus ſub Q P O, qui æqualis eſt angulo ſub N H M, æqualis quoque erit angulo ſub N L H. Unde anguli ſub N H M & ſub N L H æquales erunt, & angulus ſub L H M angulo ſub C N H ſive angulo ſub C E F æqualis. Q. E. D.

De Caſu altero Linearum Logarithmicarum.

Sint (in *Fig.* 18.) A B, C D duæ lineæ rectæ parallelæ, intra quas quælibet alia linea recta E F ducatur. Ad aſymptoton A B deſcribatur linea logarithmica G H, cujus ſubtangens ſit æqualis lineæ E F, & ordinatim applicatæ comprehendant cum aſymptoto angulos verſus contingentes æquales parti dimidiæ anguli ſub A E F. Quibus poſitis, ſi ad aſymptoton C D alia deſcribatur linea logarithmica I L M priori ſimilis & æqualis, & ſi ducantur contingentes L N, L O, dico angulum ſub O L N angulo ſub B E F eſſe æqualem.

Ducatur N P, ut angulus ſub A N P angulo ſub A E F ſit æqualis, & erit N P = E F. Sumatur N Q lineæ E F ſive ſubtangenti lineæ logarithmicæ æqualis, jungaturque Q L. Quoniam igitur Q L punctum Q conjungit cum puncto contactus L, Q L ordinatim ad aſymptoton A B applicabitur, ideoque angulus ſub L Q N verſus contingentem L N æqualis erit parti dimidiæ anguli ſub A E F vel anguli ſub A N P; eſt autem N P = E F = N Q, quoniam igitur N P, N Q ſunt æquales, & angulus ſub L Q N æqualis dimidio anguli ſub A N P, recta Q L producta tranſibit per P efficiens triangulum P N Q iſoſceles. Eâdem ratione ſi ducatur O S, ut angulus ſub C O S æqualis ſit angulo

ſub AEF erit OS = EF ; ſi vero ſumatur OR = EF, ducaturque RL, ordinatim ea applicabitur ad aſymptoton CD, & producta tranſibit per S, propterea quod linea IM ſimilis eſt & æqualis lineæ GH. Erit autem angulus ſub PRL (= angulo ſub LSQ) = angulo ſub LQS = angulo ſub NPQ. Unde erit angulus ſub LSQ = angulo ſub NPQ, & triangula SLQ, PNQ ſimilia ſunt, anguluſque ſub SLQ = angulo ſub PNQ = angulo ſub BEF. Eſt autem & LS = LQ, OS = NQ, item angulus ſub OSL (= angulo ſub ORS) = angulo ſub NQL. Triangula igitur OSL, NQL æqualia ſunt, habentia baſes OL, NL æquales, & angulos ſub NLQ, OLS, etiam æquales : auferatur communis angulus ſub NLS, & relinquetur angulus ſub OLN = angulo ſub SLQ = angulo ſub BEF. Q. E. D.

De Cycloide.

Sint (in *Fig.* 19.) AB, CD duæ rectæ lineæ parallelæ, quas EF ad perpendiculum ſecet. In diametrum EF deſcribatur ſemicirculus EGF, & eo ſemicirculo deſcribatur ſemicyclois FH. Jam ſi alia ſemicyclois ILQ priori ſimilis & æqualis ſed ſitu inverſo intra parallelas deſcribatur, & ſi contingentes LM, LN ducantur, dico angulum ſub MLN rectum eſſe.

Sit IOP ſemicirculus, quo deſcribitur ſemicyclois IQ, ejus diameter IP ; ducatur LGO, lineis AB, CD parallela, & jungantur FG, GE, IO. Erit deinde contingens LM parallela rectæ FG, & contingens LN parallela rectæ IO, quæ parallela eſt rectæ EG. Angulus igitur ſub MLN = eſt angulo ſub FGE recto, ideoque angulus ſub MLN rectus eſt. Q. E. D.

De Parabolâ Semicubicâ.

Si (in *Fig.* 20.) rectam lineam AB alia recta linea CD interſecat in puncto D cum lineâ AB angulum quemcunque conſtituens; & ſi ſumatur DE = ½ DC; deinde ducatur EF, ut DF ſit = DE; & denique diametro CF & vertice C deſcribatur parabola ſemicubica GCH, quæ tranſeat per punctum E, habeatque ordinatim applicatas ad diametrum CF lineæ FE parallelas: his poſitis, ſi parabola hæc ad lineam AB in ſitu inverſo deſcripta ſit, ut eandem in ſitu jam dicto deſcriptam interſecet, & contingentes ad punctum interſectionis ducantur, illæ contingentes ſe interſecabunt in angulo æquali angulo ſub CDB.

Sumatur in parabolâ GCH punctum quodvis I, ducatur ILC, & ſumptâ EM = EL ducatur MNC. Deinde ordinatim applicentur OIP, NQR, ducaturque CEV, item EX diametro CO parallela. His poſitis erit VX : XE :: EF : FC, & XE : XP :: DF : EF. Unde ex æquo ut VX : XP :: DF : FC, dividendoque ut VX : VP :: DF : DC. Quoniam igitur eſt DF = DE = ½ DC, eſt etiam VX = ½ VP. Porro ut IO*q* : EF*q* :: CO*c* : CF*c* :: VO*c* : EF*c*. Quatuor igitur ratione continuatâ proportionalium eſt VO ſecunda, quarum IO eſt prima & EF ultima. Eſt autem & IO : OV :: LF : EF. Ideoque ſunt IO, OV, FL, FE quatuor ratione continuatâ proportionales; unde ut VO : LF :: LF : EF :: VO — LF : LE, componendoque ut LF + EF : EF :: VO — EF (= VX) : LE. Demonſtratum autem fuit VX æqualem eſſe dimidio lineæ VP. Ut igitur 2 LF + 2 EF : EF :: VP : LE :: 2 LFE + 2 EF*q* : EF*q*. Jam vero ut IO : LF (:: IV : LE) :: LF*q* (2 LFE + LE*q* — EF*q*) : EF*q*, propterea quod lineæ IO, VO

V O, L F, E F ſunt quatuor ratione continuatâ proportionales; quoniam igitur ut V P : L E : : 2 L F E + 2 E F q : E F q, erit ut P I : L E : : 3 E F q — L E q : E F q. Eodem modo demonſtratur ut N R : E M :: 3 E F q — E M q : E F q. Cum igitur E M = ſit E L, erit N R = P I, ſunt autem parallelæ, ideoque puncta N, I æqualiter diſtant a linea A B. Si igitur parabola ſemicubica G C H in ſitu inverſo ad lineam A B deſcribatur, punctum N incidere poteſt in punctum I. Parabolæ huic detur ille ſitus inverſus $h c g$, & ducantur contingentes I Γ S, E W, Δ N T, t I δ; item lineæ W L Y, W Z M. Erit ex naturâ parabolæ hujus O S = $\frac{2}{3}$ O C, F W = $\frac{2}{3}$ F C, & Q T = $\frac{2}{3}$ Q C. Eſt autem & F D = $\frac{1}{3}$ F C; unde F D, D E, & D W ſunt æquales, & angulus ſub F E W rectus: &, cum E L ſit = E M, erunt & anguli ſub E W L, E W M æquales. Quoniam autem L M F lineis I O, N Q parallela eſt, & lineæ O C, F C Q C ſimiliter dividuntur in punctis S, W, T, erit W L Y contingenti I S Γ parallela, & W Z M contingenti Δ N T. Eſt igitur angulus ſub W Y D = angulo ſub I Γ t, & angulus ſub W Z D = angulo ſub N Δ D = angulo ſub I t Γ. Porro cum anguli ſub E W L, E W M ſint æquales, & anguli ſub D E W, D W E etiam æquales propter linearum D W, D E æqualitatem, erit angulus ſub Y W D = angulo ſub W Z D. Ideoque angulus ſub C D B, qui æqualis eſt ſummæ angulorum ſub W Y D & ſub Y W D, æqualis erit ſummæ angulorum ſub I Γ t, & ſub I t Γ, nimirum angulo ſub Γ I δ æqualis. Q. E. D.

Lond. Aug. 27. 1722.

VIII. *An*

VIII. *An Account of a Book, intituled,* Harmonia Menſurarum, ſive Analyſis & Syntheſis per Rationum & Angulorum menſuras promotæ : accedunt alia Opuſcula Mathematica : per *Rogerum Coteſium.* Edidit & auxit *Robertus Smith,* Coll. Trin. Cantab. & Reg. Soc. Socius; Aſtronomiæ & Experimentalis Philoſoph. poſt *Coteſium* Profeſſor. *Cantabrigiæ* 1722. in 4to. Proſtant apud Bibliopolas Londinenſes.

THE Book conſiſts of three Parts. In the firſt, called *Logometria,* the Author's chief Deſign is to ſhew how that ſort of Problems, which are uſually reduced to the Quadrature of the *Hyperbola* and *Ellipſis,* may be reduced to the the Meaſures of Ratio's and Angles; and afterwards be ſolved more readily by the Canons of Logarithms and Sines and Tangents. He defines the Meaſures of Ratio's to be quantities of any kind, whoſe Magnitudes are analogous to the Magnitudes of the Ratio's to be meaſured. In this Senſe any Canon of Logarithms is a Syſtem of numeral Meaſures of the Ratio's of the abſolute Numbers to an Unit: The Parts of the Aſymptote of the Logiſtic Line, intercepted between its Ordinates, are a Syſtem of Linear Meaſures of the Ratio's of thoſe Ordinates: The Areas of an *Hyperbola,* intercepted between its Ordinates to the Aſymptote, are a Syſtem of Plane Meaſures of the Ratio's of thoſe Ordinates: And ſince there may be infinite Syſtems of Meaſures according as

as various kinds of Quantities are made uſe of, ſuch as Numbers, Time, Velocity, and the like; or according as the Meaſures of any one Syſtem may be all increaſed or diminiſhed in any given proportion; in ſuch Variety much Confuſion may poſſibly ariſe as to the Kind and abſolute Magnitudes of particular Meaſures, which happen to fall under Conſideration. Our Author very happily removes this Difficulty; by ſhewing that the Nature of the Subject points out the Meaſure of a certain immutable Ratio for a *Modulus* in all Syſtems, whereby to determine the Kind and abſolute Magnitudes of all other Meaſures in each Syſtem.

The firſt Propoſition is to find the Meaſure of any propoſed Ratio. This he conſiders in a way ſo ſimple and general, as naturally leads to the Notion and Definition of a *Modulus*; namely, that it is an invariable Quantity in each Syſtem, which bears the ſame Proportion to the Increment of the Meaſure of any propoſed Ratio, as the increaſing Term of the Ratio bears to its own Increment. He then ſhews, that the Meaſure of any given Ratio is as the *Modulus* of the Syſtem, from whence it is taken: and that the *Modulus* in every Syſtem is always equal to the Meaſure of a certain determinate and immutable Ratio, which he therefore calls the *Ratio Modularis*. He ſhews that this Ratio is expreſſed by theſe Numbers 2,7182818 *&c.* to 1, or by 1 to 0,3678794 *&c.* So that in *Briggs*'s Canon the Logarithm of this Ratio is the *Modulus* of that Syſtem: In the Logiſtic Line the given Subtangent is the *Modulus* of that Syſtem: In the *Hyperbola* the given Parallelogram, contained by an Ordinate to the Aſymptote and the Abſciſs from the Center, is the *Modulus* of that Syſtem: and in other Syſtems the *Modulus* is generally ſome remarkable Quantity. In the ſecond Propoſition he gives a

conciſe uncommon Method for calculating *Briggs*'s Canon of Logarithms; together with Rules for finding intermediate Logarithms and Numbers, even beyond the Limits of the Canon. In the 3d Propoſition he conſtructs any Syſtem of Meaſures by a Canon of Logarithms; not only when the Meaſure of ſome one Ratio is given, but alſo without that *Datum*, by ſeeking the *Modulus* of the Syſtem by the Rule abovementioned. In the 4th, 5th, and 6th Propoſitions he ſquares the *Hyperbola*, deſcribes the Logiſtic Line and Æquiangular Spiral by a Canon of Logarithms, and ſhews ſome curious Uſes of theſe Propoſitions in their *Scholia*. Take an eaſy Example of the Logometrical Method, in the common Problem for finding the Denſity of the Atmoſphære. Suppoſing Gravity uniform, every one knows, that if Altitudes are taken in any Arithmetical Progreſſion, the Denſities of the Air in thoſe Altitudes will be in a Geometrical Progreſſion; that is, the Altitudes are the Meaſures of the Ratio's of the Denſities below and in thoſe Altitudes, and ſo the difference of any two Altitudes is the Meaſure of the Ratio of the Denſities in thoſe Altitudes. Now to determine the abſolute or real Magnitude of theſe Meaſures, the Author ſhews, *a priori*, that the *Modulus* of the Syſtem is the Altitude of the Atmoſphære, when reduced every where to the ſame Denſity as below. The *Modulus* therefore is given (as bearing the ſame Proportion to the Altitude of the Mercury in the Barometer, as the ſpecific Gravity of Mercury does to the ſpecifick Gravity of Air) and conſequently the whole Syſtem is given. For ſince in all Syſtems the Meaſures of the ſame Ratio's are analogous among themſelves; the Logarithm of the Ratio of the Air's Denſity in any two Altitudes will be to the *Modulus* of the Canon, (that is, to the Logarithm of

the *Ratio Modularis* defined above,) as the difference of thoſe Altitudes is to the aforeſaid given Altitude of the homogeneous Atmoſphære.

He concludes the Logometria with a *General Scholium*, containing great Variety of elegant Conſtructions both Logometrical and Trigonometrical; ſuch as give the Length of Curves either Geometrical or Mechanical; their Area's and Centers of Gravity; the Solids generated from them, and the Surfaces of theſe Solids; together with ſeveral curious Problems in Natural Philoſophy, concerning the Attraction of Bodies, the Denſity and Reſiſtance of Fluids, and the Trajectories of Planets. Several of theſe Problems have two Caſes; one conſtructed by the Meaſure of a Ratio, and the other by the Meaſure of an Angle. The great Affinity and beautiful *Harmony* of the *Meaſures* in theſe Caſes, has given occaſion to the Title of the Book. The Meaſures of Angles are defined (juſt as the Meaſures of Ratio's) to be Quantities of any Kind, whoſe Magnitudes are analogous to the Magnitudes of the Angles. Such may be the Arcs or Sectors of any Circle, or any other Quantities of Time, Velocity, or Reſiſtance, analogous to the Magnitudes of the Angles. Every Syſtem of theſe Meaſures has likewiſe its *Modulus* homogeneous to the Meaſures in that Syſtem, aud may be computed by the Trigonometrical Canon of Sines and Tangents, juſt as the Meaſures of Ratio's by the Canon of Logarithms; for the given *Modulus* in each Syſtem bears the ſame Proportion to the Meaſure of any given Angle, as the *Radius* of a Circle bears to an Arc which ſubtends that Angle, or the ſame as this conſtant Number of Degrees 57,2957795130 bears to the Number of Degrees in the ſaid Angle. Upon the whole our Author thus expreſſes himſelf, *p.* 35. " Ex

" adductis

" adductis hactenus exemplis, Geometris integrum erit
" de methodo noſtrâ judicare ; quam quidem, ſi pro-
" ba fuerit, ulterius excolere pergent & excolendo la-
" tius promovebunt. Patet utique campus ampliſſi-
" mus in quo vires ſuas experiri poterunt, præſertim ſi
" Logometriæ Trigonometriam inſuper adjungant,
" quibus miram quandam affinitatem in ſe invicem
" euntibus intercedere notabam. Hiſce quidem prin-
" cipiis haud facile crediderim *generaliora* dari poſſe ;
" cum tota Matheſis vix quicquam in univerſo ſuo am-
" bitu complectatur præter Angulorum & Rationum
" Theoriam. Neque ſane *commodiora* ſperabit, qui
" animadverterit effectionis facilitatem per ampliſſi-
" mas illas, omnibuſque ſuis numeris abſolutas, tum
" Logarithmorum, tum Sinuum & Tangentium tabu-
" las ; quas anteceſſorum noſtrorum laudatiſſimæ
" ſolertiæ debemus acceptas. Ut vero tanti beneficii
" uberior nobis exſurgat fructus, id nunc exponendum
" reſtat, quibus artibus ad iſtius modi concluſiones re-
" ctiſſimâ perveniatur. In hunc finem *Theoremata*
" quædam tum *Logometrica* tum *Trigonometrica* ad-
" jeciſſem, quæ parata ad uſum aſſervo ; ni conſul-
" tius viſum eſſet, quum abſque nimiis ambagibus ea
" tradi non poſſent, intacta potius præterire atque
" aliis denuo inveſtiganda relinquere.

Why the Author takes his Principles to be ſo gene-ral, will farther appear by an Inſtance or two. In the Problem already mentioned he meaſures the Ratio of the Air's Denſities in any Altitudes, by the Altitudes themſelves, making uſe of the Altitude of an uniform Atmoſphære for the *Modulus*. So likewiſe when he conſiders the Velocities acquired, and the Spaces de-ſcribed in given Times, by a Body projected upwards or downwards in a reſiſting Medium with any given Velocity ; he ſhews, that the Times of Deſcent, added

to a given Time, are the Meaſures of Ratio's, to a given *Modulus* of Time, whoſe Terms are the Sum and Difference of the ultimate Velocity and the preſent Velocities that are acquired: that the Times of Aſcent, taken from a given Time, are the Meaſures of Angles, to a given *Modulus* of Time, whoſe Radius is to their Tangents in the Ratio of the ultimate Velocity to the preſent Velocities: and laſtly, that the Spaces deſcribed in Deſcent or Aſcent, are the Meaſures of Ratio's to a given *Modulus* of Space, whoſe Terms are the abſolute accelerating and retarding Forces ariſing from Gravity and Reſiſtance taken together at the Beginning and End of thoſe Spaces.

This general Account may ſuffice to illuſtrate what I am going to ſay; that ſince the Magnitudes of Ratio's (as well as their Terms) may be expounded by Quantities of any Kind, the Mathematician is at Liberty upon all Occaſions to chuſe thoſe which are fitteſt for his Purpoſe; and ſuch are they without doubt, that are put into his Hand by the Conditions of the Problem. He may indeed repreſent theſe Quantities by an *Hyperbola*, or any other Logometrical Syſtem, were not his Purpoſe anſwer'd with greater Simplicity by the very Syſtem itſelf, which occurs in each particular Problem. And the ſame may be ſaid for the Syſtems of Angular Meaſures, inſtead of recurring upon all Occaſions to Elliptical or Circular Area's.

As to the Convenience of calculating from our Author's Conſtructions, he ſhews that the Meaſures of any Ratio's or Angles are always computed in the ſame uniform Way; by taking from the Tables the Logarithm of the Ratio, or the Number of Degrees in the Angle, and then by finding a fourth Proportional to three given Quantities; for that will be the Meaſure

required

required. The ſimpleſt Hyperbolic Area may indeed be ſquared by the ſame Operation taught in the Author's fourth Propoſition; but the ſimpleſt Elliptic Area requires ſomewhat more. Thoſe that are more complex in both Kinds (which generally happens) require an additional Trouble to reduce them to the ſimpleſt: to ſquare them by infinite Series is ſtill more operoſe, and does not anſwer the End of Geometry. Upon the whole therefore it may deſerve to be conſidered, for what Purpoſes ſhould Problems be always conſtructed by Conic Areas, unleſs it be to pleaſe or aſſiſt the Imagination. The Deſign of Theoretical Geometry differs from Problematical; the former conſiſts in the Diſcovery and Contemplation of the Properties and Relations of Figures for the ſake of naked Truth; but the Deſign of the latter is to do ſomething propoſed, and is beſt executed by the leaſt *Apparatus* of the former.

The *Logometria* was firſt publiſhed by the Author himſelf, in the *Philoſoph. Tranſact.* of the Year 1714. No 338. But his Logometrical and Trigonometrical Theorems abovementioned were not publiſhed till after his Deceaſe. Theſe Theorems make the ſecond Part of the Book, and are calculated to give the Fluents of Fluxions (reduced to 18 Forms) by Meaſures of Ratio's and Angles; in ſuch a manner, that any Perſon may perfectly comprehend their Conſtruction and Uſe, though altogether unacquainted with Curvilinear Figures, as expreſſed by Æquations. And this Circumſtance does alſo render the Application of them to the *Analyſis* and *Conſtruction* of *Problems* extremely eaſy. Of this kind the Author has given a great many choice Examples both in abſtract and phyſical Problems; which make up the third and laſt Part of the Book.

The

The Author, a little before his Deceaſe has informed us (in a Letter of *May* 5. wrote to his Friend Mr. *Jones*) "that Geometers had not yet promoted the inverſe "Method of Fluxions, by Comic Areas, or by Meaſures of Ratio's and Angles, ſo far as it is capable of "being promoted by thoſe Methods. There is an "infinite Field (ſays he) ſtill reſerved, which it has "been my Fortune to find an Entrance into. Not to "keep you longer in Suſpenſe, I have found out a ge-"neral and beautiful Method by Meaſures of Ratio's "and Angles for the Fluent of any Quantity which "can come under this Form $\frac{dz z^{\theta n + \frac{\delta}{\lambda} n - 1}}{e + f z^n}$, in "which d, e, f are any conſtant Quantities, z the vari-"able, n any Index, θ any whole Number affirmative or "negative, $\frac{\delta}{\lambda}$ any Fraction whatever. The Fluents of "this Form which have hitherto been conſidered are $\frac{dz z^{\theta n - 1}}{e + f z^n}$ & $\frac{dz z^{\theta n + \frac{1}{2} n - 1}}{e + f z^n}$: Theſe you remember are Sir *Iſaac Newton*'s two firſt, and from "theſe all his others are eaſily deduced. And as his "irrational Forms of the quadratick Kind are derived "from the rational, ſo from my general rational "Form I deduce irrational ones of all Kinds. For in-"ſtance, if $\frac{\delta}{\lambda}$ repreſent any affirmative or negative "Fraction, the Fluent of any Quantity of this Form "$dz z^{\theta n - 1} \times \overline{e + f z^n}^{\frac{\delta}{\lambda}}$, or of this $dz z^{\theta n - 1} \times \overline{\frac{e + f z^n}{g + b z^n}}^{\frac{\delta}{\lambda}}$ and ſo of ſome others, depends upon the

" the Measures of Ratio's and Angles. Mr. *Leibnitz* " in the *Leipsic Acts* of 1702, *p.* 218 and 219, has ve- " ry rashly undertaken to demonstrate, that the Fluent " of $\frac{\dot{x}}{x^4+a^4}$ cannot be expressed by Measures of Ra- " tio's and Angles; and he swaggers upon the Occa- " sion (according to his usual Vanity) as having by " this Demonstration determined a Question of the " greatest Moment. Then he goes on thus; as the " Fluent of $\frac{\dot{x}}{x+a}$ depends upon the Measure of a " Ratio, and the Fluent of $\frac{\dot{x}}{xx+aa}$ upon the Measure " of an Angle; so he had more than once expressed " his Wishes, that the Progression may be continued, " and it be determined to what Problem the Fluents of " $\frac{\dot{x}}{x^4+a^4}$, $\frac{\dot{x}}{x^8+a^8}$, &c. may be referred. His De- " sire is answered in my general Solution, which " contains an infinite Number of such Progressions. " I can go yet farther, and shew him how by Mea- " sures of Ratio's and Angles, without any Exception " or Limitation, the Fluent of this general Quantity " $\frac{\dot{z}z^{\theta n+\frac{\delta}{\lambda}n-1}}{e+fz^n+gz^{2n}}$ or even this $\frac{\dot{z}z^{\theta n+\frac{\delta}{\lambda}n-1}}{e+fz^n+gz^{2n}+hz^{3n}}$ " may be had; where θ, as before, represents any Inte- " ger, and the Denominator λ of the Fraction $\frac{\delta}{\lambda}$, re- " presents any Number in this Series, 2. 4. 8. 16. 32. &c. " any whole Number being denoted by its Numerator " δ. In truth I am inclined to believe, that Mr. *Leib-* " *nitz*'s grand Question ought to be determined

" the

" the contrary Way; and that it will be found at laſt,
" that the Fluent of any rational Fluxion whatever,
" does depend upon the Meaſures of Ratio's and
" Angles, excepting thoſe which may be had in finite
" Terms even without introducing Meaſures."

Dr. *Taylor* knowing by this Letter what the Author had done, was pleaſed to propoſe the Invention of the Fluents of the two laſt Fluxions as a Problem to the Mathematicians in foreign Parts. Mr. *Bernoulli* in the *Leipſic Acts* of 1719. *p.* 256, did ſhew accordingly how they are reducible to Conic Area's. The Editor has publiſhed the Author's own Solution by Meaſures of Ratio's and Angles; and upon this Foundation has conſtructed new Tables of Logometrical and Trigonometrical Theorems, for the Fluents of Fluxions reduced to 94 Forms, part rational and part irrational. He has likewiſe added general Notes upon the chief Difficulties in the Book, together with a Method of compoſing Synthetical Demonſtrations of Logometrical and Trigonometrical Conſtructions, illuſtrated by various Examples.

The firſt Treatiſe in the *Miſcellaneous Works* is concerning the *Eſtimation of Errors in Mixt Mathematicks.* It conſiſts of 28 Theorems, to determine the Proportions among the leaſt contemporary Variations of the Sides and Angles of Plane and Sphærical Triangles, while any two of them remain invariable. An Example will ſhew their great Uſe in Aſtronomy. The Time of the Day or Night is frequently to be determined by the Altitude of ſome Star. Let it then be propoſed to find the Error, that may ariſe in the Time, from any given Error in taking the Altitude. By applying the 22d Theorem to the Triangle form'd by the Complements of the Star's Altitude and Declination

and

and by the Complement of the Pole's Elevation, the Author ſhews, that the Variation of the Angle at the Pole, and conſequently the Error in Time, will be as the Error in the Altitude directly, as the Sine Complement of the Pole's Elevation inverſely, and as the Sine of the Star's *Azimuth* from the Meridian inverſely. Conſequently, if the Error in the Altitude be given, under a given Elevation of the Pole, the Error in Time will be reciprocally as the Sine of the *Azimuth* contained by the Meridian and the Vertical which the Star is in. This Error therefore will be the ſame, whatever be the Altitude of the Star in the ſame Vertical; and will be leaſt when the Vertical is at right Angles to the Meridian. But will be abſolutely the leaſt in the ſame Circumſtance, if the Obſerver be under the Æquator. In which Caſe, if the Error in the Altitude be one Minute, the Error in the Time will be four Seconds, If the Obſerver recedes from the Æquator towards either Pole, the Error will be increaſed in the Proportion of the Radius to the Sine Complement of the Latitude: So that in the Latitude of 45 Degrees it will be $5\frac{1}{3}$ Seconds, and in the Latitudes of 50 and 55 it will be $6\frac{2}{9}$ and $6\frac{37}{38}$ Seconds reſpectively. If the Star be in any other vertical Oblique to the Meridian, the Error will ſtill be increaſed in the Proportion of the Radius to the Sine of that oblique Angle. Laſtly, if the Error in the Altitude be either bigger or leſs than one Minute, the Error in Time will be bigger or leſs in the ſame Proportion. Much after the ſame manner may the Limits of Errors be computed in other Caſes, which ariſe from the Inaccuracy of Obſervations, and from hence the moſt convenient Opportunities for obſerving are alſo determined.

The Second Treatiſe is concerning the *Differential Method*. The Author having wrote it, before he had

ſeen Sir *Iſaac Newton*'s Treatiſe upon that Subject, has handled it after a manner ſomewhat different.

The Title of the Third Treatiſe is *Canonotechnia*, or concerning the Conſtruction of Tables by Differences. It conſiſts of ten Propoſitions, moſt admirably contrived for expeditious Computation of intermediate Terms in any given Series. The laſt Propoſition, which contains a general Solution of the whole Deſign, is this; *Datis ſeriei cujuſcunque terminis aliquot æquidiſtantibus, quorum intervalla ſecanda ſunt in æquales quotlibetcunq; partes, propoſitum ſit invenire terminos interſerendos.*

The Book concludes with three ſmall Tracts, concerning the Deſcent of Bodies, the Motion of Pendulums in the Cycloid, and the Motion of Projectiles, compoſed in a very natural and eaſy manner.

The Author has wrote ſome other Pieces, yet unpubliſh'd, which the Editor has given an Account of in his Preface to the Book.

The Reader will find every Subject treated with uncommon Elegance and Simplicity.

FINIS.

LONDON: *Printed for* W. *and* J. Innys, *Printers to the* Royal Society, *at the* Prince's Arms *the Weſt End of St.* Paul's Churchyard.



FIG. III.



FIG. V.



I

M

J. Shirt sculp.





FIG. VI.



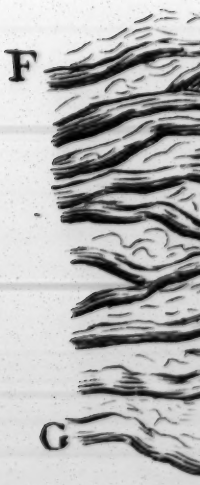


FIG. I.

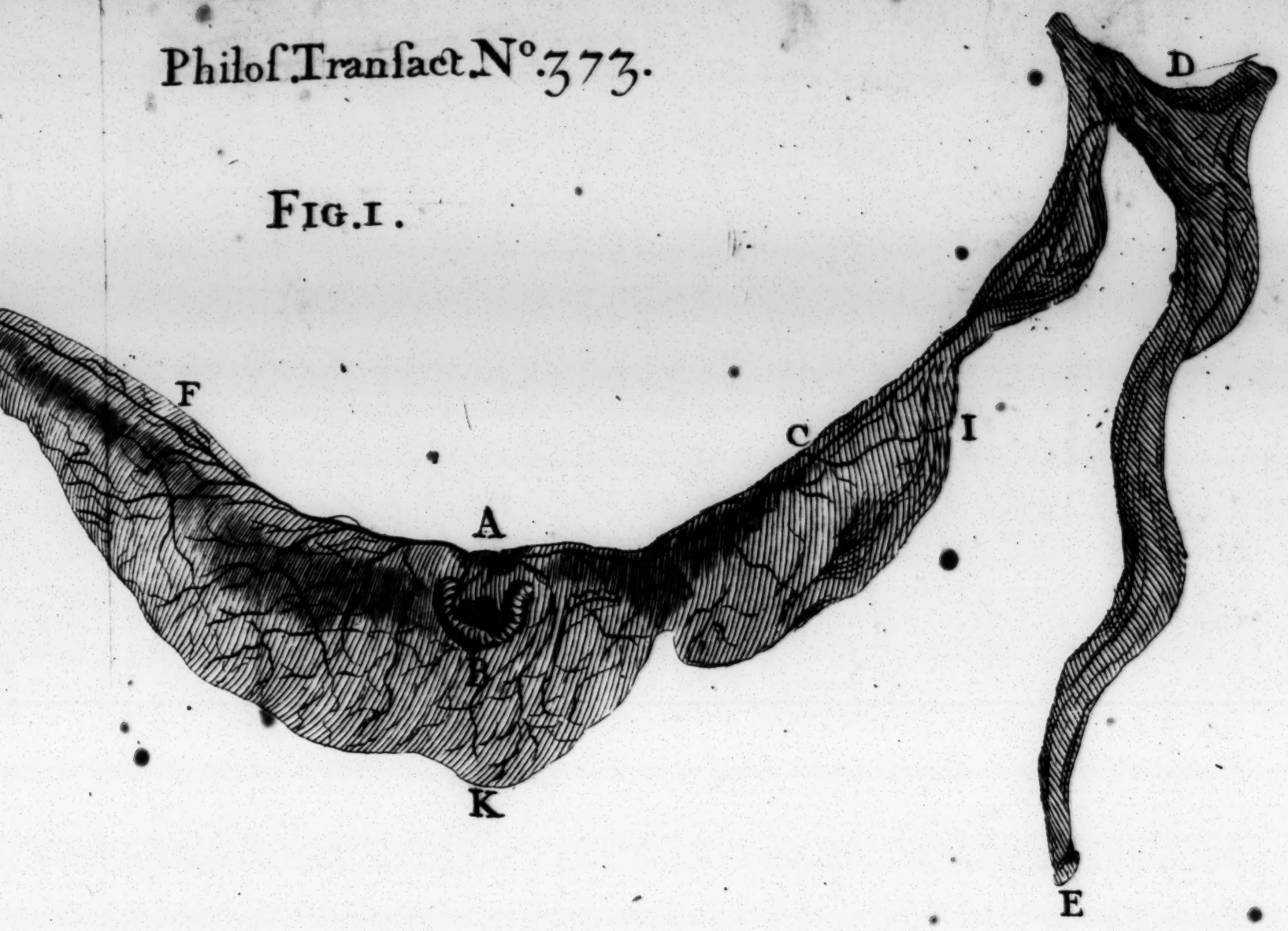


FIG. II.

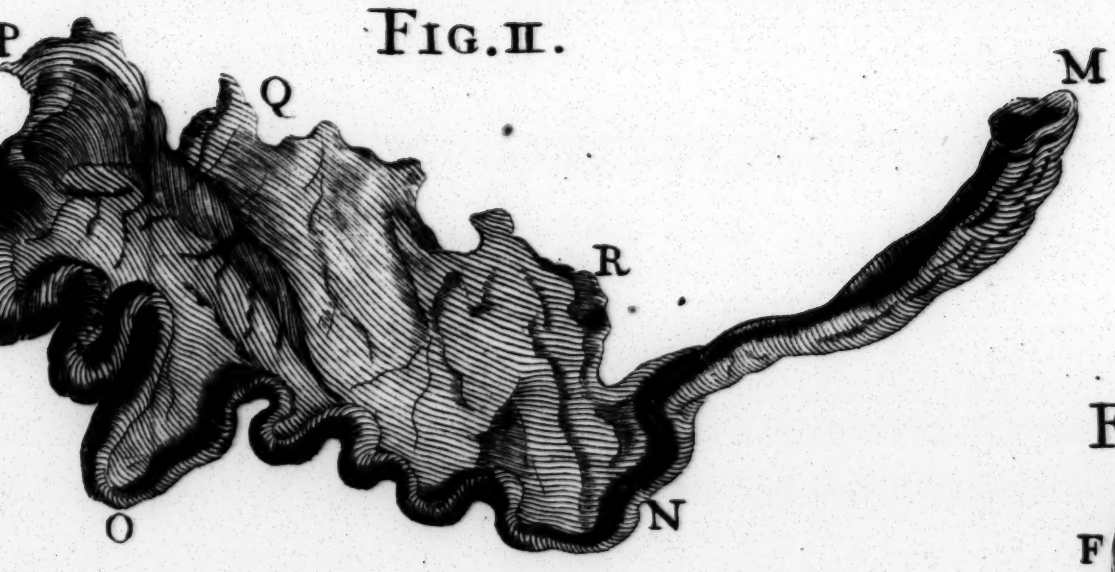


FIG. III.



FIG. IV.



FIG. V.



FIG. VII.

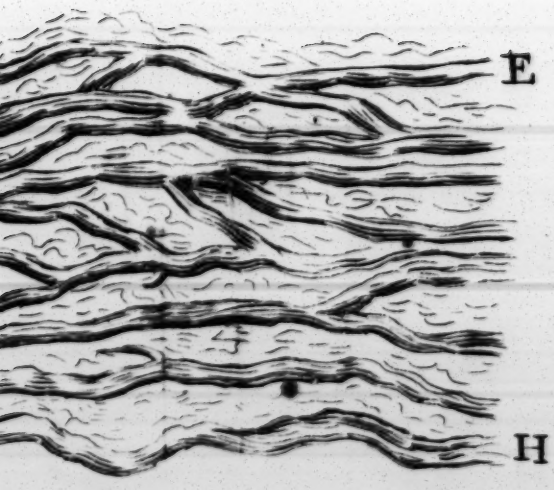
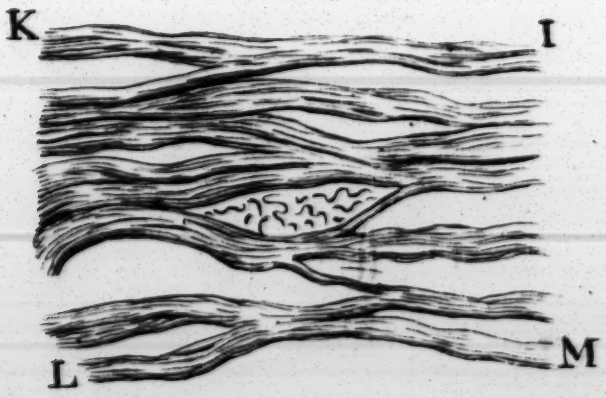


FIG. VIII.



BRITISH MUSEUM

J. Shirt sculp.

Jos: Banks

Numb. 373.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *September* and *October*. 1722.

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II. *Obſervations upon the* Callus *of the Hands and Feet, by the ſame curious Gentleman. Tranſlated by* John Chamberlayne, *Eſq;*

III. De Fractionibus Algebraicis Radicalitate immunibus ad Fractiones Simpliciores reducendis, deque ſummandis Terminis quarumdam Serierum æquali Intervallo a ſe diſtantibus. Auctore *Abrahamo de Moivre*, S. R. Socio.

IV. *De-*

IV. *Defenſio Diſſertationis de Motu Aquarum fluentium, in Actis Philoſophicis,* N° 355. *editæ, contra Animadverſiones Viri Cl.* Petri Antonii Michelotti. *Auctore* Jacobo Jurin, *M. D. Coll. Med. Lond. Soc. in Theatro Publico Chirurg. Lond. Prælectore Anatomico, & Soc. Reg. Secr.*

V. *An Account of a remarkable Inſtance of the Infection of the Small Pox. By Dr.* Jurin, *Soc. Reg. Secret.*

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ERRATUM.

N° 372. p. 146. l. 2. read, *May 5th*, 1716.

I. *Obſervations*

I. *Obſervations upon a* Fœtus, *and the Parts of Generation of a Sheep. In a Letter to the* Royal Society, *from Mr.* Leeuwenhoek, *F. R. S. Tranſlated from the* Dutch *by Dr.* Sprengell, *F. R. S.*

A Certain Butcher kept, about a League from this Town, ſeveral young Wethers at Graſs, with one Ewe, which within two Years time had twice lamb'd. This Ewe being very fat, he reſolv'd to kill; and to this end he brought it to another Paſture juſt by the Town, where he had ſeveral other young Wethers; but it happen'd, that among them there was one young Ram, which he judged to the be about twenty Weeks old; this young Ram cover'd the Ewe in his preſence; ſoon after which the Butcher kill'd the Ram, but left the Sheep about five Days longer in the Paſture before he kill'd it; out of which Sheep's Belly he ſaid that he cut 28 Pounds of Fat. But obſerving, upon opening the Ewe, that the *Uterus* was four times bigger than ordinary, he brought the *Uterus*, with the *Ovaria*, to me, aſſuring me, that it was not yet quite five Days ſince the young Ram had cover'd the Sheep, and that there was no other Ram thereabouts.

This *Uterus* I put in an earthen glaz'd Pan, and cover'd it over, in order to diſſect it next Morning, it being pretty late in the Evening when the Butcher brought it me. I then began firſt to try to penetrate into the Womb from the *Vagina*, with the Point of a

ſmall Pair of Sciſſars, but I found it ſo cloſe, that I could not enter it, therefore I cut a piece off from the Womb, out of which ran a clear Water, and within it lay the *Fœtus* with all its Coverings. I ſpread this upon the backſide of a *China* Tea-Diſh, and finding that it ſtill contained more Water, I made a ſmall Inciſion to drain it, and to let it dry, that I might obſerve it the better. I could plainly ſee the *Vertebræ* of the Neck and Back, as alſo the Joints of its ſhort Tail; I thought likewiſe that I ſaw the Eyes. But when it was quite dry, I could not obſerve its Backbone ſo well as before, when it was as yet moiſt, tho' the Painter, who made the Draught, and had ſharper and younger Eyes than mine, ſaw the Bones of the Back very diſtinctly. My Deſign in drying it was to cut it in ſmall Slices, that then I might the better obſerve the inner Parts, for it was ſo extremely ſoft and tender when moiſt, that with the leaſt Touch its Parts would be diſorder'd and confounded. Therefore I cut this *Fœtus* into fifteen Slices, and obſerv'd them with a Microſcope, but could not be very certain what I ſaw. I thought that I ſaw the Inteſtines, as alſo the Bladder; and coming to the Breaſt, I fancied that I ſaw the Heart; but I ſaw and obſerv'd, with a great deal of Pleaſure, that two Blood-Veſſels lay near together in the Brain, and how they were ſpread into Branches. I had this *Fœtus* drawn as it lay in its Teguments. See *Fig.* 1. A B being the *Fœtus*, and A C D E I K and A F G H L K, the Membranes wherewith it was involved, in the manner as I had ſpread and dried them, wherein the Blood-Veſſels, as much as poſſible, are delineated. Now ſome Perſons might expect, that I ſhould have look'd for the Extremities of the Blood-Veſſels: but no, the Blood-Veſſels have no end, as I have frequently ſaid. Beſides, they become

become gradually ſo exquiſitely fine, that the Blood, which paſſes thro' them, can exhibit no red Colour to our Eyes; ſo that there is no tracing them when entring into the Veſſels that return the Blood back to the Heart, except in living Animals, where one may ſee the Blood enter into the returning Veſſels. Before the Butcher gave me this *Uterus*, he ſqueez'd it betwixt his Fingers, and told me that he could feel nothing in it; and this I believe he had done ſeveral times before, by which means he tore off the Veſſels by which the *Fœtus* was faſten'd to the *Uterus*; which I ſuppoſe was the occaſion that, upon opening the *Uterus*, the *Fœtus* with its Coverings came ſo eaſily forth.

I alſo took a Draught of the *Tuba Fallopiana*. See *Fig.* 2. M N O P. At P, is the imaginary Orifice, which is thought to ſuck the Egg from the *Ovarium*, according to the old abſurd Notion; at M is ſhewn where the *Tuba* increaſes in Bigneſs, and at Q R the fleſhy Subſtance, which I cut away from the *Uterus*. I then had alſo cut off the ſo call'd *Ovaria*, and the pretended *Ova*, which latter were much too big to think that they could paſs upon Conception thro' the *Tubæ Fallopianæ*. I therefore took the length of the *Fœtus* with a Pair of Compaſſes, and meaſur'd it upon a divided Braſs Rule, and this I did alſo as to its Breadth; I then took the middle Number between theſe, and multiplied it twice by itſelf, to bring it to a Cube Number. I next took the Length of the *Axis* of an *Ovum*, as it lay in the *Ovarium* inclos'd in its Membranes, and taking the Cube of that length, and dividing one Cube Number by the other, I found that ſuch an *Ovum* was about ſeven times bigger that the *Fœtus*, notwithſtanding it had had near five Days Growth. I ſhew'd this *Fœtus*, with its Covertures, to two Phyſi-

cians and one Surgeon, and I gave them the pretended *Ovaria* in their Hands, and they agreed, that not one *Ovum* was missing out of the *Ovaria*. Then I ask'd them what they thought? how it was possible that such an *Ovum* could pass thro' the Falloppian Tube? Whereupon the one said, that the *Ovarium* was quite out of doors, and that it was nothing but some fleshy Substance. But the other said, that notwithstanding this, all Animals came from an Egg, and the last told me, that he believed that Tube to be neither of a Sheep nor a Lamb; but I shew'd them that it was from an Ewe which at least had lamb'd twice, and yet that the Tube was neither thicker nor wider than the Tube of a Lamb. Here I could observe more than ever, how hard it is to bring Mankind off from their Prejudices, when once they have laid them down as Principles.

After having kept these *Ovaria* some Days, by which means they were pretty much shrunk in the drying, I order'd them to be drawn, that the Bigness of the Eggs might be observ'd. See *Fig.* 3. A B C D E is the *Ovarium*, which was on that side of the *Uterus*, in which the *Fœtus* had lain. You must observe that the *Uterus* of a Sheep is divided by a Membrane, so that the young ones cannot touch one another. D E A is the part where it was fastened. In this *Ovarium* you may observe a round Protuberance, which is beset with several others; this great Protuberance is what is called an *Ovum*. This *Ovarium* is not here represented so large, as it was, when I cut it off from the Parts that it grew to. There was besides, at one side of that *Ovarium*, a large round Body, grown to the *Ovarium*, which seem'd also to be an *Ovum*. This is delineated in *Fig.* 4. F G, on which there appear'd several other little round Bodies protuberant from it. Now on the other side of the *Uterus*, there was a

large

large fleſhy prominent *Ovum* (as it is call'd) which might plainly be obſerved without a Microſcope, whoſe Bigneſs is likewiſe drawn in *Fig.* 5. at H I, upon which you may likewiſe obſerve a ſmaller round Body, and out of that again other ſtill ſmaller round Bodies appear protuberant. After I had quite dried theſe Eggs, repreſented in *Fig.* 3, 4 and 5, I ſtill obſerv'd more and more of the prominent round Bodies upon them, inſomuch that upon one of them, I told ſixteen round little Bodies, whereof ſome, by loſing all their Moiſture, were ſunk in and had a Dent in the middle. Furthermore, I cut theſe Eggs, with a very fine ſharp Knife, into thin Slices, and then obſerving them with a Microſcope, I ſaw Blood-Veſſels in them, and alſo other ſorts of Veſſels, which I did not take for Blood-Veſſels, and among the reſt one ſo big, that a Hair of ones Head might enter it, beſides abundance of others exceeding ſmall. After many Obſervations, I could think no otherwiſe, but that the ſo call'd Eggs conſiſted of nothing but Veſſels, and that the ſuperfluous Moiſture, which was ſent to theſe Eggs, did not circulate (except only what was in the Blood-Veſſels) and by overcharging the Veſſels did elevate them into theſe ſmall Protuberances, and ſometimes burſting them, did thereby leave a Dent in the middle; which Dent having been obſerv'd by ſome Perſons, they firmly believ'd, that that was the Place where the *Ovum* was ſuck'd out, from whence ſprung the *Fœtus*. I was very ſorry that I did not get this *Uterus* without its having been ſqueez'd, for I do not queſtion, but that I might otherwiſe have plainly diſcover'd all the Members of this *Fœtus*, ſince I could plainly obſerve its Backbones even with the naked Eye, and that in a *Fœtus* not of quite five Days Growth. I hope after this, nobody will pretend to ſay, that the Animal *in Utero*

at

at the Beginning, is nothing but an unform'd Mass. These Observations I made in the Month of *September*, 1718.

Delft, June 13. 1722.

II. *Observations upon the* Callus *of the Hands and Feet, by the same curious Gentleman. Translated by* John Chamberlayne, *Esq*;

IN the Month of *September*, 1719. feeling an acute Pain in one of my Feet, at the Joint between the Foot and the little Toe, which I imagined to proceed from the more than usual Thickness of the *Callus* or hard Skin, upon that part; I caused my Servant, partly with his Nails, and partly with a Penknife, to take off that hard Skin, and let it fall upon a blue Paper, that I had set my Foot upon.

This *Callus*, or hard Skin, was compos'd of little scaly Shivers lying upon one another, and the whole Piece was as large as a small Nail of a Man's Hand.

I view'd the said Shivers thro' a Microscope, but could not satisfy myself, because they lay so irregularly on each other.

Moreover, I took a little Bit of the aforesaid hard Skin, laid it on a clean Glass-Plate, steep'd it in pure Rain-Water, and gently dividing it with a Piece of a Quill, I was amazed to see into what a vast Number of Particles it separated, and that with as much Readiness, as if they had never been join'd.

Afterwards

Afterwards I took two or three of the ſaid Particles, of which many were of the Figure of a Weaver's Shuttle, being broad in the middle and pointed at each End, with a Line in the middle, like thoſe upon the uppermoſt or outſide Skin of Fruits, or of our Bodies, but generally irregular; they were very thick in Proportion to their Bigneſs. I took, I ſay, two or three of the ſaid Particles, and laid them on a clean Glaſs, and put to them a Drop of Water, as large as a coarſe Grain of Sand, and divided the ſame as well as I was able; and viewing the divided Particles thro' a Microſcope, I was aſtoniſhed at the prodigious number of exceeding ſmall Particles that occurr'd to my Sight, and which were of the ſame Figure as beforeſaid.

Moreover, I took ſome of the thickeſt Pieces of the horny Skin, but not half ſo thick as the Back of a ſmall Knife, and ſlit them into as thin Slices as I could, and placed them upon a clean Glaſs, with the Deſign of diſcovering the exceeding thin Particles lying upon one another; and having moiſten'd them, they ſpread themſelves out further, and when they became dry again, they ſeparated into ſeveral Parts; and I obſerv'd likewiſe that each of theſe ſeparated Parts were compoſed of many thinner Particles lying on each other. In order to have a clearer Notion of the Contexture of thoſe Particles, by which the Skin of the Hands and Feet of thoſe who are inured to hard Labour, or walk much, increaſes in Thickneſs, and is ſurrounded, I cauſed a ſmall Portion of the aforeſaid ſeparated Particles to be drawn, as appears by *Fig.* 6. A B C D, tho' they were not all ſo exact and compleat, as they are repreſented in the ſaid Figure; and according to the beſt of my Obſervation, they had

had all been ſeparate Pieces, and none of them united to one another.

Again I placed ſeveral little Pieces of this hard Skin, which I had cut off at the thickeſt Part of it, before a Microſcope, and moiſten'd them with fair Rain-Water when I put them upon the Glaſs-Plate, by which Means they acquired a great Extent; and being dry'd, they ſhrunk again, and thereby appear'd in ſeveral long Particles, and each of them ſeem'd to conſiſt of other long Particles, as they are repreſented in *Fig.* 7. E F G H. So that E H or F G, was the Thickneſs of that Piece of thick Skin, which I had cut through.

From this Obſervation, I conſider'd with myſelf, whether one of theſe long ſtripe-like Particles, ſuch as appear'd to the Eye at E F or H G, might not be the Thickneſs which the horny Skin had acquir'd in the Space of a Month; and whether the very thin Particles, which appear'd in ſuch a little Stripe, were not the Accretion which the hard Skin receiv'd in one Day. This laſt mention'd little Piece, repreſented by *Fig.* 7. was not ſo large to the naked Eye as a common Grain of Sand. And whereas I placed before a Microſcope another very ſmall Piece of Skin, that was ſomething thinner than the former, I could perceive the exceeding thin Particles repreſented by *Fig.* 8. I K L M, which were the *Strata*, or Beds, in which the horny Particles of the Skin lay, and ſo compoſed the Thickneſs thereof.

For my further Satisfaction, I ſent for a Maſon's Servant, who was a laborious Workman, and cut out of his Hand, where it was moſt thick and brawny, two Bits of the hard Skin; and then I ſlit it into ſmall Slices, and obſerved eaſily enough the thin Particles lying upon each other, but could not ſeparate the little

Scales

Scales, of which each little *Stratum* of the hard Skin conſiſted, becauſe, as I fancy'd, thro' the hard working of the Man, the Particles of the ſaid Skin were ſo preſſed upon one another, and ſo cloſely join'd, that they could be no longer ſeparated.

Now foraſmuch as the Hands of the Maſons or Bricklayers are often cover'd with the ſharp Salts of the Chalk or Lime, which might prevent the Separation of the very ſmall Parts of the hard Skin; I ſent for a Maſter-Carpenter, who was likewiſe a diligent Workman, and viewing his Hands, in order to pare off ſome of the Brawn thereof, I found them as ſoft in the Palms, as if he had never been uſed to Labour; upon which I ſaid to him, you waſh your Hands very often I believe: to which he reply'd, ten times a Day at leaſt, for I hate to ſee them foul. Then I ſent for a Ploughman, who was moſtly a Tiller of Corn-Land; this Perſon's Hands were very hard; however, I cut two Pieces of horny Skin out of them, which after I had done, I cut them in little Bits, but they were ſo hard, that a ſharp Knife, which I us'd, got ſeveral Notches in doing it. And I obſerv'd that the uppermoſt part of the Skin was full of little Rents, and all the *Strata* were preſſed ſo cloſely together, that I could not make any Diſcoveries therein, ſave only that the little Beds lay on each other, and that the Thickneſs of the Skin conſiſted thereof.

Furthermore I put the two Pieces of hard Skin into warm Water, in order to ſoften them, and then to ſeparate the Parts from each other, but could not do it, becauſe they were ſo ſtrongly joyn'd together.

I have ſeveral times obſerved, in waſhing my Hands, that when I rubb'd the Palms of my Hands ſtrongly againſt one another, with very little Water between them, ſome Particles would be rubb'd off from the Skin, and continue between my Hands.

For my farther Satisfaction in this Matter, I put one of my Fingers into fair Rain-Water, and with that waſhed the Part of my Thumb which is join'd to my Hand; after which I rubb'd both Finger and Thumb hard againſt each other, then I gently ſcraped with a Pen-knife, the Matter, which I had looſen'd from the Skin by moiſtening and rubbing it; and taking off a little of that which ſtuck to the Knife, I put it upon a clean Glaſs-Plate, and ſetting it before a Microſcope, I ſaw with Aſtoniſhment the great number of Particles of Skin, which lay ſcatter'd upon the Glaſs, but were more irregular than thoſe, which I ſeparated from the brawny Skin of my Foot, and which were not very cloſely preſſed together, becauſe I don't walk much, it being troubleſome to me at my great Age.

After this I moiſten'd the back of my Hands, and then rubb'd them ten or twelve times againſt each other, and having ſo done, I ſcraped off, with a Pen-knife very gently, ſome of the Matter which I had looſen'd by rubbing; and placing it on a clean Glaſs, I view'd it with a Microſcope, after having ſeparated the Particles of the ſaid Matter from each other with a little Water, and diſcover'd abundance of little Scales which come off our Hands.

Foraſmuch as the Skin of my Hand is in no part thicker than that, which is upon my Thumb next to the Nail, having in my advanced Age chiefly uſed my Thumbs in the Examination of Microſcopical Objects, I made one of my Thumbs a little moiſt, and rubb'd the other againſt it, and placed the rubb'd off Matter before a Microſcope, thro' which I obſerv'd ſuch a prodigious Number of Particles, like thoſe repreſented by *Fig.* 6. A B C D, but all irregular, that no Man can conceive it without having ſeen it.

Now

Now as we find, that ſuch a Quantity of Particles is ſeparated from the Hands, and is daily renewed in a well conſtituted Body; we muſt conclude, that we eat ſeveral of the ſaid rubb'd off Particles in our Bread, and that they turn to Nouriſhment; and I am of Opinion, that there is hardly any Food prepared for us, eſpecially ſuch as paſſes pretty much thro' the Hands, but that ſome of the rubb'd off Particles are mix'd therewith, eſpecially when they knead Dough from Meal or Flower; and ſtill more, when the Bakers knead with their Feet, as in making of Rye-Bread.

Since theſe Obſervations concerning the Friction or rubbing of my Hands, I take more notice thereof, when I waſh and dry them, than formerly; and I ſtand amazed at the numerous Particles that daily ſeparate themſelves from my Hands, and grow on them again; and at the particular Proviſion, that is made for producing theſe Particles, in the Palms of our Hands and Bottom of our Feet, whereas we do not by far meet with ſuch a Quantity of Particles conſtantly produced in other Parts of our Body; for if we obſerve thoſe, who work much with the back of their Hands, we ſhall not meet with any of that hard Skin we have been ſpeaking of, but only a kind of Tumor, or riſing, as the Dry-ſheerers, or thoſe who dreſs Cloth, have upon their left Hands.

In ſhort, the Manner of the Production of theſe ſmall Particles will be a Myſtery to us, though our Hands and Feet muſt be fortified with ſuch a Matter, to enable them to ſupport all that Force, and Preſſure which they are obliged to undergo.

Delft, July 7.
1722.

III. De Fractionibus Algebraicis Radicalitate immunibus ad Fractiones Simpliciores reducendis, deque ſummandis Terminis quarumdam Serierum æquali Intervallo a ſe diſtantibus. Auctore *Abrahamo de Moivre*, S. R. Socio.

Eruditiſſimo Viro *JOHANNI MACHIN*, Societatis Regalis Secretario, *A. de Moivre*, S. P.

MITTO tibi excerpta quædam e Chartis meis coram Regali Societate 5° Maii 1720, *exhibitis, quibus eodem die manum appoſuerunt Secretarii. Pars altera harum Chartarum jam per biennium apud Cl. Præſidem repoſita fuerat; continebat autem Demonſtrationes Propoſitionum quarumdam in Libro a me Anglice emiſſo qui inſcriptus eſt,* THE DOCTRINE OF CHANCES. *Pars altera continebat explanationem uberiorem Demonſtrationum quas prior levius tetigerat. Jam cum ſæpius me inſtigaſti ut ſelectas Propoſitiones quaſdam ex his Chartis deſumptas publici juris facerem, utpote exiſtimans in illis quædam reperiri quæ ad res majoris momenti quam ſit ſpeculatio ludorum applicari poſſint; huic tuo deſiderio tandem obtempero, idque eo libentius, quo mihi videor jure aliquo a Te itidem impetrare poſſe ut pulcherrima tua inventa in Publicum proferre diutius non reluctteris.* Vale.

2 Auguſt. 1722.

PRO-

PROPOSITIO I.

Si sit Fractio quælibet $\frac{1}{1 - ex + fx\,x - gx^3 \text{ \&c.}}$, *cujus Numerator sit data Quantitas, & Denominator sit Multinomium utcunque compositum ex datis,* 1, e, f, g, &c. *& indeterminata* x, *dico Fractionem supradictam ad Fractiones simpliciores reducibilem fore.*

Casus Primus.

Sit Fractio proposita $\frac{1}{1 - ex + fx\,x}$; finge Denominatorem $1 - ex + fx\,x = 0$, sintque $\frac{1}{m}$, $\frac{1}{p}$ radices istius Æquationis, sive facto $x\,x - ex + f = 0$, sint m, p, radices Æquationis novæ, fac $A = \frac{m}{m - p}$, atque $B = \frac{p}{p - m}$, & erit Fractio proposita æqualis summæ $\frac{A}{1 - mx} + \frac{B}{1 - px}$.

Casus Secundus.

Sit Fractio proposita $\frac{1}{1 - ex + fx\,x - gx^3}$; fingatur $x^3 - ex\,x + fx - g = 0$, sintque m, p, q, radices istius Æquationis, pone $A = \frac{mm}{m - p \times m - q}$,

B =

$B = \frac{pp}{p-m \times p-q}$, $C = \frac{qq}{q-m \times q-p}$; &

erit Fractio propoſita æqualis ſummæ $\frac{A}{1-mx}$

$+ \frac{B}{1-px} + \frac{C}{1-qx}$.

Caſus Tertius.

Sit Fractio propoſita $\frac{1}{1-ex+fxx-gx^3+hx^4}$.

Fingatur $x^4 - ex^3 + fxx - gx + h = o$, ſintque m, p, q, s, Radius iſtius Æquationes, pone $A = \frac{m^3}{m-p \times m-q \times m-s}$, $B = \frac{p^3}{p-m \times p-q \times p-s}$, $C = \frac{q^3}{q-m \times q-p \times q-s}$, $D = \frac{s^3}{s-m \times s-p \times s-q}$, eritque Fractio propoſita æqualis ſummæ $\frac{A}{1-mx} + \frac{B}{1-px} + \frac{C}{1-qx} + \frac{D}{1-sx}$.

Caſus Quartus.

Sit Fractio propoſita $\frac{1}{1-ex+fxx-gx^3+hx^4-kx^5}$, fingatur $x^5 - ex^4 + fx^3 - gxx + hx - k = o$, ſintque m, p, q, s, t, Radices iſtius æquationis; pone $A = \frac{m^4}{m-p \times m-q \times m-s \times m-t}$, $B = \frac{p^4}{p-m \times p-q \times p-s}$

$\times p-s \times p-t$, $C = \frac{q^4}{q-m \times q-p \times q-s \times q-t}$,

$D = \frac{s^4}{s-m \times s-p \times s-q \times s-t}$, $E = \frac{t^4}{t-m \times t-p \times t-q \times t-s}$. Eritque Fractio propoſita æqualis ſummæ, $\frac{A}{1-mx} + \frac{B}{1-px} + \frac{C}{1-qx} + \frac{D}{1-sx} + \frac{E}{1-sx}$. Lex Reductionis ita uno intuitu ſe prodit, tamque facilis eſt illius continuatio ut inutile foret illam verbis explanare.

Corollarium I.

Si Radices omnes ſint æquales, non poterit Fractio propoſita reduci ad ſimpliciores.

Corollarium II.

Si Radices aliquæ ſint æquales, aliæ vero inæquales, poterit reduci fractio propoſita ad ſimpliciores; ſit *v. g.* fractio propoſita $\frac{1}{1-ex+fxx-gx^3}$, factoque ut præſcriptum eſt $x^3 - exx + fx - g = 0$. Sint Radices iſtius æquationis m, p, q, quarum m & p ſint æquales: erunt fractiones ſimplices in quas reſolvitur propoſita $\frac{mm}{m-p \times m-q \times 1-mx} + \frac{pp}{p-m \times p-q \times 1-px} + \frac{qq}{q-m \times q-p \times 1-qx}$; addantur duæ priores in unam ſummam, & erit ſumma

(diviſis

(divisis Numeratore & Denominatore per $m - p$)

$$\frac{mp - q \times m + p + mpqx}{m - q \times p - q + 1 - mx \times 1 - px}, \text{ sive}$$

$$\frac{mm - 2qm + mmqx}{|m - q|^2 \times |1 - mx|^2} \text{ sive } \frac{m}{|m - q| \times |1 - mx|^2} - \frac{qm}{|m - q|^2 \times |1 - mx|^2}$$

adeoque Fractiones reductæ erunt

$$\frac{m}{|m - q| \times |1 - mx|^2} - \frac{qm}{|m - q|^2 \times |1 - mx|^2} + \frac{qq}{|m - q|^2 \times |1 - qx|}.$$

Corollarium III.

Si Fractiones simplices in quas resolvitur Fractio proposita involvant Quantitates imaginarias, tunc quicquid est imaginarii semper destruetur per additionem duarum vel plurium fractionum numero pari sumptarum.

Corollarium IV.

Ex combinatione Fractionum simplicium, & apta limitatione Radicum, plurima suborientur Theoremata in quibus inerit concinnitas quædam minime aspernanda Ex. *g.* sit fractio proposita $\frac{1}{1 - ex + fxx - gx^3 + hx^4}$, factoque ut antea $x^4 - ex^3 + fxx - gx + h = 0$. Sint m, p, q, s, Radices Æquationis, sintque Fractiones in quas resolvitur proposita, $\frac{A}{1 - mx} + \frac{B}{1 - px} +$

$+\frac{C}{1-qx}+\frac{D}{1-sx}$. Ponatur $q=-m$, atque $s=-p$; addantur ſimul duæ priores, itemque duæ poſteriores, & reducetur fractio propoſita ad $\frac{m+p-mpx}{2\times\overline{m+p}\times\overline{1-mx}\times\overline{1-px}}+\frac{}{2\times\overline{m+p}}$ $\frac{m+p+mpx}{\times\overline{1+mx}\times\overline{1+px}}$ ſi vero ponatur $p=-m$, atque $s=-q$, & addantur duæ priores, itemque duæ poſteriores, reducetur Fractio propoſita ad $\frac{}{mm-qq}$ $\frac{mm}{\times 1-mmxx}+\frac{qq}{qq-mm\times 1-qqxx}$.

PROPOSITIO II.

Si ſit Fractio quælibet cujus Numerator ſit data Quantitas, & Denominator ſit Trinomium vel Quadrinomium vel Quinquinomium, &c. *radicalitate non affectum & utcunque compoſitum ex datis,* 1, e, f, g, h, &c. *& indeterminata* x *atque dividator Numerator per Denominatorem, ut habeatur Series Infinita; dico fore ut, ſi ſumantur Termini quilibet iſtius ſeriei æqualibus intervallis a ſe invicem diſtantibus, ſeries infinitæ inde reſultantes, ſummabiles futuræ ſint.*

Exemplum I.

Sit Fractio propoſita $\frac{1}{1-x-xx}$; reducatur illa

ad ſeriem infinitam, nempe ad $1 + x + 2xx + 3x^3 + 5x^4 + 8x^5 + 13x^6 + 21x^7 + 34x^8$ &c. ſumanturque termini omnes alterni, incipiendo a primo, itidemque ſumantur Termini omnes alterni, incipiendo a ſecundo, hincque conficiantur ſeries binæ,

Videlicet, $1 + 2xx + 5x^4 + 13x^6 + 34x^8$ &c.
$x + 3x^3 + 8x^5 + 21x^7 + 55x^9$ &c.

Fingatur Denominator Fractionis propoſitæ, $1 - x - xx = 0$, jam cum indices poteſtatum indeterminatæ x, in novis ſeriebus ſe invicem ſuperent communi differentia 2, pone $xx = z$, atque ope duarum æquationum $1 - x - xx = 0$, & $xx = z$, exterminetur x; fietque $1 - 3z + zz = 0$; jam nunc reſtituatur x, & erit $1 - 3xx + x^4 = 0$; dividatur hæc æquatio per primam, quotiens erit $1 + x - xx$; ſumantur alternatim Termini quotientis, propter Terminos alternatim ſumptos in ſerie propoſita, hincque orientur ſummæ duæ, $1 - xx$, & x; conſtituantur hæ ſummæ Numeratores Fractionum duarum quarum communis Denominator ſit $1 - 3xx + x^4$. eruntque $\frac{1 - xx}{1 - 3xx + x^4}$ & $\frac{x}{1 - 3xx + x^4}$ ſummæ reſpectivæ novarum Serierum.

Exemplum II.

Si vero deſiderentur ſummæ terminorum intervallis binis a ſe diſtantium, fiat ut prius $1 - x - xx = 0$; jam cum indices poteſtatum in novis ſeriebus ſe invicem ſuperunt communi differentia 3, ponatur $x^3 = z$, & fiet $1 - 4z - zz = 0$, atque reſtituto x, fiet $1 - 4x^3 - x^6 = 0$; dividatur $1 - 4x^3 - x^6$ per $1 - x - xx$, quotiens erit $1 + x + 2xx - x^3 + x^4$, cujus termini ordinatim ſumpti ad intervalla bina, tres conficient

conficient ſummas, videlicet, $1 - x^3$, $x + x^4$, $2xx$, quæ ſigillatim ſumptæ, erunt illæ Numeratores, trium Fractionum, quibus ſi apponatur communis Denominator $1 - 4x^3 - x^6$, erunt tres Fractiones, $\frac{1 - x^3}{1 - 4x^3 - x^6}$, $\frac{x + x^4}{1 - 4x^3 - x^6}$, $\frac{2xx}{1 - 4x^3 - x^6}$, ſummæ tres Terminorum omnium binis intervallis a ſe diſtantium, incipiendo reſpective a primo, ſecundo & tertio Termino; atque eodem methodo colligere licet ſummas terminorum ternis vel quaternis vel quinis intervallis a ſe diſtantibus, ſive denominator ſit quadrinomium, vel multinomium quodcunque ex terminis finitis compoſitum.

PROPOSITIO III.

Si dividatur Unitas per Trinomium utcunque compoſitum ex datis 1, e, f, g, &c. *& indeterminata* x; *dico Terminum quemvis Seriei ex hac diviſione reſultantis, aſſignabilem fore.*

Sit Trinomium $1 - ex + fxx$ finge $xx - ex + f = o$, ſint m & p, radices Æquationis; ſit $l + 1$ locus termini deſiderati, hoc eſt exprimat l intervallum inter primum Terminum & Terminum quæſitum, fac $A = \frac{m}{m - p}$ $B = \frac{p}{p - m}$. Et erit Terminus deſideratus $\overline{Am^l + Bp^l} \times x^l$.

Eodem modo ſi dividatur Unitas per quadrinomium $1 - ex + fx\,x - g\,x^3$, pone $x^3 - e\,x\,x + fx - g = o$, ſintque m, p, q, radices Æquationis, fac $A = \frac{mm}{\overline{m - p} \times \overline{m - q}}$, $B = \frac{pp}{\overline{p - m} \times \overline{p - q}}$, $C =$

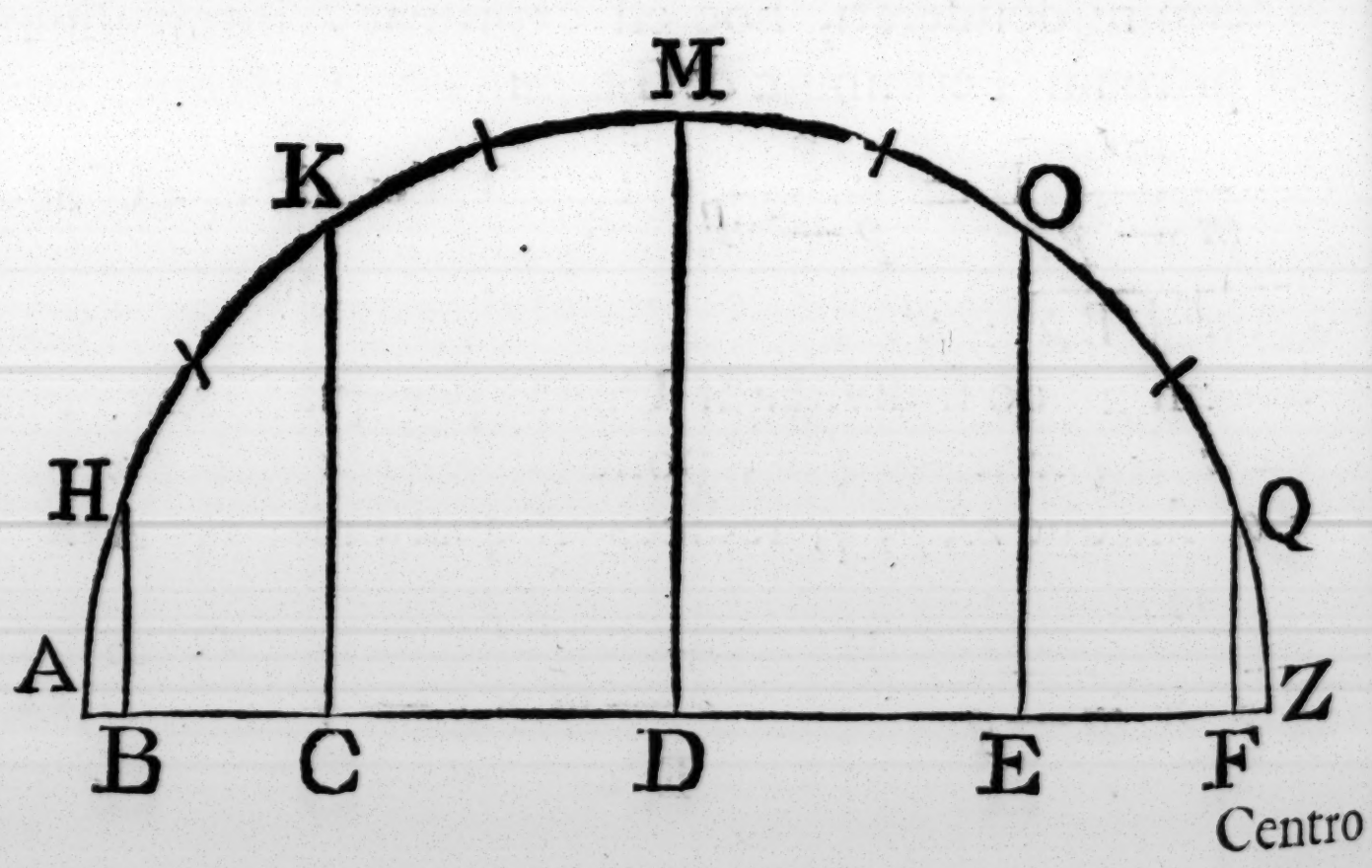
$\frac{qq}{\overline{q-m} \times \overline{q-p}}$. Et erit Terminus defideratus $\frac{}{Am^l + Bp^l + Cq^l \times x^l}$, & lex eadem obtinet pro multinomiis quibuſcunque.

PROBLEMA.

A & B *quorum Dexteritates ſint in ratione data videlicet ut* a *ad* b, *ea conditione ludant, ut quoties* A *ludum unum vicerit,* B *tradat ipſi nummum unum: quoties vero* B *vicerit,* A *tradat ipſi nummum unum: & non prius ludo deſiſtant, quam eorum alter nummos omnes alterius lucratus fuerit ; quæritur quantum probabile futurum ſit ut certamen intra datum ludorum numerum* x, *vel expirante illo numero, finiatur.*

Caſus Primus.

Sit *n* numerus nummorum quos uterque Colluſorum habeat; ſit etiam *n* numerus par, ponaturque *a* ad *b* habere rationem æqualitatis.



Centro D, Intervallo D A = 1, deſcribatur Semicircumferentia A M Z quæ dividatur in tot partes æquales quot ſunt unitates in n, tunc ex primo H, tertio K, quinto M &c. & impari quoque diviſionis termino, demittantur ad diametrum perpendicula H B, K C, M D, O E, Q F &c. ponatur $Q = \frac{HB^{x+1}}{AB^{\frac{1}{2}x+1}} - \frac{CK^{x+1}}{AC^{\frac{1}{2}x+1}} + \frac{DM^{x+1}}{AD^{\frac{1}{2}x+1}} - \frac{EO^{x+1}}{AE^{\frac{1}{2}x+1}} + \frac{QF^{x+1}}{AF^{\frac{1}{2}x+1}}$ &c. donec ſinus omnes exhauriantur: quo facto, erit probabilitas certaminis finiendi intra ludos non plures quam x, ad probabilitatem non finiendi, ut $2^{\frac{1}{2}x-1}n - Q$ ad Q, accurate.

Corollarium I.

Si ſumatur pro Q Terminus primus $\frac{HB^{x+1}}{AB^{\frac{1}{2}x+1}}$ neglectis cæteris, habebitur approximatio ſufficiens niſi forte ſit x numerus valde exiguus.

Exemplum.

Sit n numerus nummorum quos uterque Colluſorum habeat = 10. Sit etiam $x = 76$. Si ſumatur pro Q primus terminus & negligantur cæteri, invenietur probabilitas certaminis finiendi intra ludos non plures quam 76 ad probabilitatem non finiendi ut 50747 ad 49235, ſi vero ſumatur pro Q termini duo priores neglectis cæteris, invenietur ratio probabilitatum ut 50743 ad 49247.

Coroll-

Corollarium II.

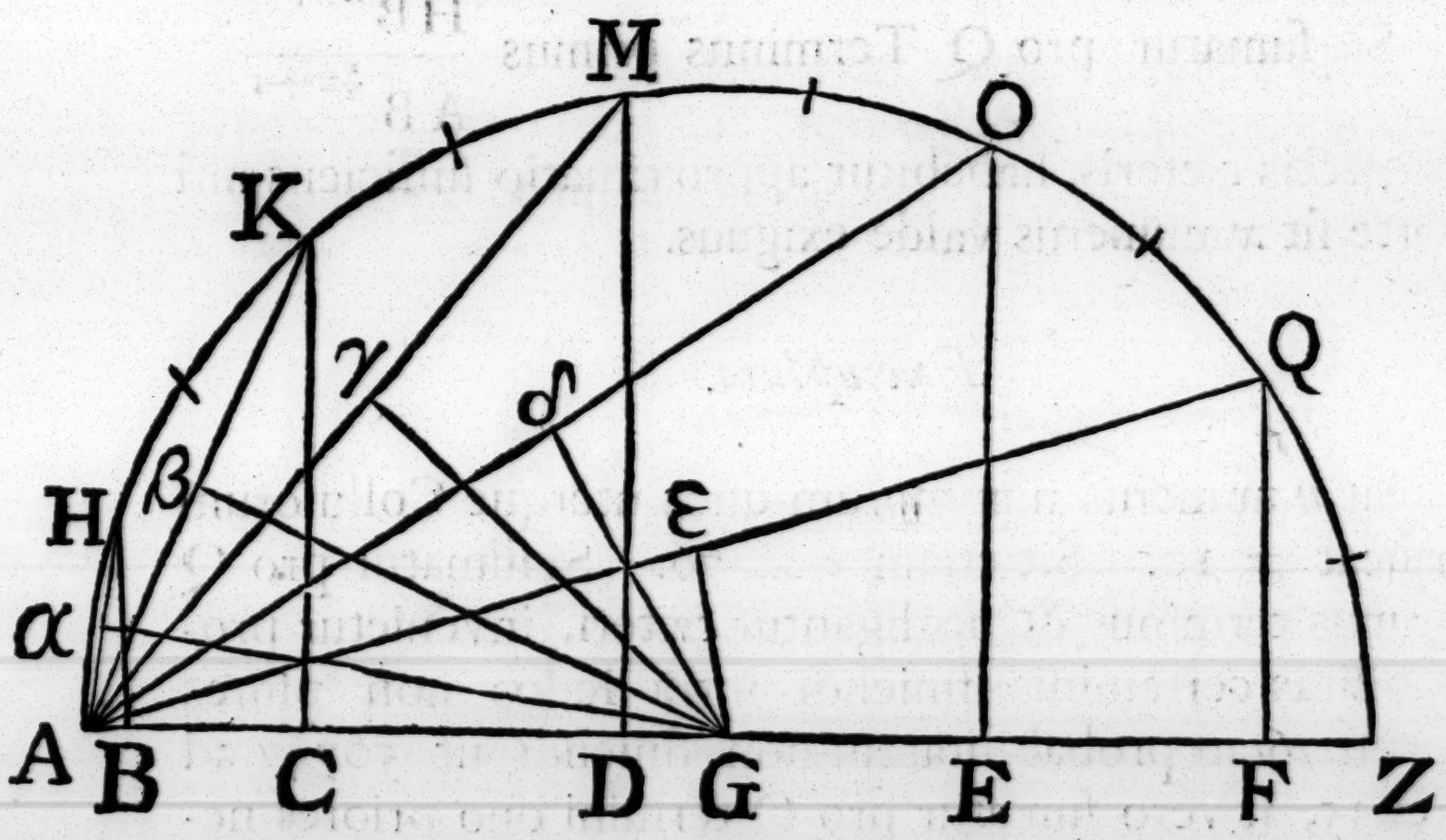
Invenire quotenis ludis, probabilitates certaminis finiendi & non finiendi erunt æquales.

Solutio.

Ponatur pro Q Terminus unicus $\frac{HB^{x+1}}{AB^{\frac{1}{2}x+1}}$, fiatque $2^{\frac{1}{2}x-1} \backslash n - Q = Q$. Et posito n maximo numero invenietur, $x = 0.756\ n\,n$ proxime, aliquanto major quam $\frac{3}{4}n\,n$.

Casus Secundus.

Sit n numerus impar, ponaturque a ad b habere rationem æqualitatis.



Centro G, intervallo G A describatur semicircumferentia A M Z quæ dividatur in tot partes æquales, quot sunt

ſunt unitates in n; tunc ex primo H, tertio K, quinto M, & impari quoque diviſionis termino, demittantur ad diametrum perpendicula HB, KC, MD, OE, QF &c. ex diametri extremitate A, primo ſcilicet arcui contermina, ducantur ſubtenſæ AH, AK, AM, &c. ad quas e Centro G ducantur perpendicula $G\alpha$, $G\beta$, $G\gamma$, $G\delta$, $G\varepsilon$, &c. ponatur $Q = \frac{BH^{x} \times G\alpha}{AB^{\frac{x+1}{2}}} - \frac{CK^{x} \times G\beta}{AC^{\frac{x+1}{2}}} + \frac{DM^{x} \times G\gamma}{AD^{\frac{x+1}{2}}} - \frac{EO^{x} \times G\delta}{AE^{\frac{x+1}{2}}} + \frac{FQ^{x} \times G\varepsilon}{AF^{\frac{x+1}{2}}}$ &c. quo facto, erit probabilitas certaminis finiendi intra ludos non plures quam x, ad probabilitatem non finiendi, ut $2^{\frac{x-3}{2}} n - Q$ ad Q accurate.

Corollarium I.

Si ſumatur pro Q terminus primus $\frac{HB^{x} \times G\alpha}{AB^{\frac{x+1}{2}}}$ neglectis cæteris, habebitur approximatio ſufficiens.

Exemplum.

Sit n numerus nummorum quos uterque Colluſorum habeat $= 45$. Sit etiam $x = 1519$. Sumatur pro Q terminus primus neglectis cæteris, & invenietur probabilitas certaminis finiendi intra ludos non plures quam 1519 ad probabilitatem non finiendi ut 49959 ad 50441, quæ proportio eſt vero proxima.

Corol.

Corollarium II.

Invenire quotenis ludis probabilitates certaminis finiendi & non finiendi erunt æquales.

Solutio.

Ponatur pro Q Terminus unicus $\frac{HB^x \times G\alpha}{AB^{\frac{x+1}{2}}}$, fiat. $\frac{x-3}{2}$ que $2^{\quad 2}\ n - Q = Q$; & posito n magno numero, invenietur $x = 0,756\ nn$ proxime aliquanto major quam $\frac{1}{4}\ nn$ contra quam sentiebat Clàrissimus Monmortius.

Casus Tertius.

Positis cæteris ut in primo çasu, sit a ad b ratio inæqualitatis (*vid. Fig.* 1.) Pone $\frac{a^n + b^n}{\overline{a+b}|^n} = L$, $\frac{\overline{a-b}|^2}{\overline{a+b}|^2} = d$, $\frac{ab}{\overline{a+b}|^2} = r$, Fac, 1, 2 $r :: \frac{HBq}{AB}, m :: \frac{CKq}{AC}$, $p :: \frac{MDq}{AD}, q :: \frac{OEq}{AE}, s :: \frac{QFq}{AF}, t.$

Pone $Q = \frac{HB}{2rAB+d} m^{\frac{1}{2}x} - \frac{CK}{2rAC+d} p^{\frac{1}{2}x} + \frac{MD}{2rAD+d} q^{\frac{1}{2}x}$ &c. quo facto erit probabilitas ludi finiendi intra ludos non plures quam x ad probabilitatem non finiendi ut $nr^{\frac{1}{2}n-1} - 2LQ$ ad $2LQ$.

Corol-

Corollarium II.

Si ſumatur pro Q Terminus primus $\frac{HB}{2rAB+d}$ $m^{\frac{1}{2}x}$ neglectis cæteris, habebitur approximatio ſufficiens.

Caſus Quartus.

Poſitis cæteris ut in ſecundo caſu, ſit *a* ad *b* ratio inæqualitatis (*vid. Fig.* 2.)

Pone quantitates L, *d*, *r*, *m*, *p*, *q*, *s*, *t*, &c. ut in tertio caſu.

Pone $Q = \frac{BH \times G\alpha}{2rAB+d} m^{\frac{x-1}{2}} - \frac{CK \times G\beta}{2rAC+d} p^{\frac{x-1}{2}} + \frac{DM \times G\gamma}{2rAD+d} q^{\frac{x-1}{2}}$ &c. quo facto erit probabilitas ludi finiendi intra ludos non plures quam *x* ad probabilitatem non finiendi ut $nr^{\frac{n-3}{2}} - 4LQ$ ad $4LQ$.

Corollarium.

Si ſumatur pro Q Terminus unicus $\frac{BH \times G\alpha}{2rAB+d} m^{\frac{x-1}{2}}$ neglectis cæteris habebitur approximatio ſufficiens.

Quemadmodum in Progreſſione Geometricâ, Terminus quilibet ad proxime præcedentem habet rationem datam, ita ſunt aliæ Progreſſiones quæ ſic conſtitui poſſunt ut aſſumptis ad libitum Terminis duobus primis, Terminus quilibet ſubſequens ad duos proxime præcedentes habeat rationes datas, hujuſmodi eſt ſubjecta Series,

A B C D E F

$1+3x+7xx+17x^3+41x^4+99x^5$, &c. in qua

$C = 2Bx+1Axx$

$D = 2Cx+1Bxx$

$E = 2Dx+1Cxx$

$F = 2Ex+1Dxx$ &c.

Quantitates autem Numerales $2+1$ *ſimul ſumptas ſubque propriis ſignis connexas appellare licet Indicem Relationis.*

Eodem modo conſtitui poſſunt ſeries aliæ in quibus aſſumptis ad libitum Terminis tribus primis, Terminus quilibet ſubſequens ad tres proxime præcedentes habeat rationes datas; hujus generis eſt ſubjecta Series.

A B C D E F

$1+2x+3xx+10x^3+34x^4+97x^5$ &c. in qua

$D = 3Cx-2Bxx+5Ax^3$

$E = 3Dx-2Cxx+5Bx^3$

$F = 3Ex-2Dxx+5Cx^3$ &c.

Quantitates autem Numerales $3-2+5$ *ſimul ſumptæ ſubque propriis ſignis connexæ, componunt Indicem Relationis.*

Sunt aliæ ſeries in quibus Relatio fit ad quatuor, vel ad quinque, vel ad ſex Terminos præcedentes, &c.

Series autem omnes hujus generis recurrentes appellare licebit propter Relationem Terminorum perpetuo recurrentem.

PROBLEMA II.

In ſeriebus recurrentibus, ex datis Terminis duobus primis, ſi relatio fiat ad duos præcedentes; vel datis

datis Terminis tribus primis, ſi relatio fiat ad tres præcedentes, &c. dato etiam indice relationis, invenire ſummam Terminorum quotlibet quorum numerus datus ſit.

Problema ſolvitur in Tractatu noſtro qui inſcribitur, *The Doctrine of Chances.*

PROBLEMA III.

Aſſumptis ad libitum ſeriebus quotcunque recurrentibus; Terminiſque, iiſdem intervallis a principio ſerierum diſtantibus, in ſe invicem multiplicatis, invenire ſummam ſeriei ex hac multiplicatione reſultantis.

INVESTIGATIO.

I° Proponantur ſeries duæ, ſitque $m + n$ Index Relationis in prima ſerie, atque $p + q$ Index Relationis in ſecunda, ex primo Indice $m + n$, formetur Æquatio $x\,x - m\,x - n = 0$, ex ſecundo Indice $p + q$, formetur Æquatio $y\,y - p\,y - q = 0$, pone $x\,y = z$. Atque ope trium iſtarum Æquationum, expungantur x & y, & orietur Æquatio $z^4 - m\,p\,z^3 - m\,m\,q\,z\,z - m\,n\,p\,q\,z + n\,n\,q\,q = 0$. $- n\,p\,p - 2\,n\,q$.

in qua deleto primo termino z^4, mutatis ſignis omnibus, atque poſito $z = 1$, obtinebitur Index Relationis, quo obtento, ſeries reſultans facile ſummabitur; II° eodem modo procedere licet, ſi dentur ſeries tres vel quatuor &c. recurrentes.

Dum ſuperiores paginæ prælo ſubjiciebantur, incidi fortuito in Acta Leipſ. *annorum* 1702 *&* 1703, *quibus comperi Cla.* Leibnitium *eadem fere methodo ante me uſum fuiſſe qua hic utor in reducendis Fractionibus Algebraicis ad ſimpliciores, quod monitum velim ut a me avertam vel minimam ſuſpicionem, aliena mihimet arrogare voluiſſe ; Propoſitio autem qua id præſtitimus æque ac Propoſitio noſtra tertia, ambæ deducuntur tanquam Corollaria ex altera Propoſitione maxime generali quam exhibuimus coram Regali Societate,* Maii 5° 1720 ; *Propoſitio ſic ſe habet.*

Data ſerie quâvis recurrente quarum Termini quotlibet primi ad libitum ſumantur ; dato etiam Indice Relationis Terminorum ſequentium ad præcedentes, invenire Terminum quemlibet aſſignatum in hac ſerie, priuſquam ſumma ſeriei ſit cognita.

Qui autem rite perſpexerit Solutionem Problematis hic adducti, is utique percipiet illam pendere a Propoſitione noſtra generali, cujus demonſtrationem ſimulque modum inveſtigationis brevi ſpero publici juris faciam.

IV. *Defensio Dissertationis de Motu Aquarum fluentium, in Actis Philosophicis,* N° 355. *editæ, contra Animadversiones Viri Cl.* Petri Antonii Michelotti. *Auctore* Jacobo Jurin, *M. D. Coll. Med. Lond. Soc. in Theatro Publico Chirurg. Lond. Prælectore Anatomico, & Soc. Reg. Secr.*

IN pervolvendo Opere pererudito Viri Clarissimi, *Petri Antonii Michelotti,* de separatione fluidorum in corpore animali, qui *Venetiis* nuper ad nos delatus est, pluribus in locis Dissertationem meam de Motu aquarum fluentium, in *Actis Philosoph.* N° 355. ante aliquot annos editam, non leviter notatam deprehendi. Cum autem alia ex iis, quæ reprehendit Vir Doctissimus, ex minus perspecto Dissertationis meæ instituto profecta videantur; alia vero ita demonstrari possint, ut ipsum Virum Cl. ea mihi non difficulter concessurum putem: operæ pretium erit, si primo in loco Dissertationis meæ propositum & consilium paulo luculentius exponam; quod cum fecero, ad reliqua deinceps breviter expendenda progrediar.

Principio igitur explicandum est, quid in Dissertatione istâ intelligendum velim, per *Motum Aquæ ex imi vasis foramine defluentis.* Est enim alius *Motus,* sive *quantitas Motûs,* Aquæ, quæ ex vase per foramen delabitur: qui *Motus* est in ratione compositâ, ex ratione quantitatis aquæ dato quovis tempore effluentis ex foramine, & ratione velocitatis, quâcum effluit. Alius vero est *Motus* totius aquæ, seu Cataractæ aqueæ, quæ intra vas versus

foramen

foramen deſcendit, & mox effluxura eſt. Hic eſt in ratione ſummæ omnium factorum, ex ſingulis aquæ particulis, Cataractam conſtituentibus, ductis in velocitates earundem reſpectivas. Quorum Motuum cum alterum ſæpe pro altero accipi viderem, animus mihi erat poſteriorem illum in prædictâ Diſſertatione illuſtrare, ad calculum revocare, & liquoribus in Animalium corpore fluentibus applicare.

Hic ergo cum ſemper mihi intelligeretur per *Motum Aquæ defluentis*, ſive per *Motum Aquarum fluentium*, quod ex omnibus meis Propoſitionibus luculenter apparet, jure meo dicere poteram *Motum hunc a nemine adhuc, quod ſcirem, fuiſſe determinatum*: quippe quem nemo Mathematicorum, quos quidem ego viderim, nec etiam verbo tenus attigerit. Quod cum ita ſit, miror profecto non animadvertiſſe neque acutiſſimum *Michelottum*, nec etiam ſubtiliſſimi & perſpicaciſſimi Ingenii Virum, *Johannem Bernoullium*, me in illius Diſſertationis Proœmio, quod toties citat & tantopere reprehendit *Cl. Michelottus*, ne verbum quidem ſcripſiſſe de velocitate, quâcum aqua effluit ex foramine, multo minus de Bernoullianâ determinatione illius velocitatis. Hoc ſi perſpexiſſet Vir Cl. noluiſſet ſane, pro ſuâ humanitate, tam inclementer & inique mecum agere, ut me *Bernoullianam Demonſtrationem extenuare verbis conari* * diceret, & *meram eſſe cavillationem id, quod Bernoullio objiciam.* Quod vero ſubjicit, verba iſta mea, " fieri omnino " non poſſe, ut Motus aliquis cum pondere quieſcente " conferatur," *ne umbram quidem habere rationis contra Bernoullianam Demonſtrationem pugnantis*, libens agnoſco, quippe qui, cum iſta ſcriberem, tan-

* *Pag.* 131, 132.

tum

tum de Cl. Bernoullio, quantum de Sinenſium Imperatore cogitabam. Aio autem Lectorem quemvis non iniquum, neque præjudiciis occupatum, ne *umbram quidem* veriſimilitudinis reperturum, quod iſta verba ad Bernoullianam Demonſtrationem quicquam pertineant; quibus ſcilicet de re longe diversâ agatur, nempe de quantitate Motûs totius aquæ verſus foramen contendentis. Quoniam vero ita penitus inſedit animo Viri Doctiſſimi illa Demonſtratio, eandem in illius gratiam, ubi prius meipſum ab reliquis ejus Animadverſionibus vindicavero, ad examen revocare decrevi.

Ad *Motum* prædictum definiendum non alio nobis opus erat, quam Theoremate noſtro generali, quod tertio loco poſuimus: ſed cum Curvæ Hyperbolicæ Newtonianæ proprietatem, quâ Cataractam aquæ deſcendentis format, non indignam cenſeremus contemplatione Geometrarum, voluimus obiter quædam de Cataractâ illâ præmittere. Hanc autem ex Viri Incomparabilis, *Prop.* 36. *Lib.* 2. *Princip.* deſumptam proponebam, non ut *ex Tripode editam*, ſed evidentiâ Mathematicâ, omnibus oraculis certiore, munitam.

Quod enim Cataracta talis formari debeat ex aquâ libere deſcendente, & acceleratâ in modum corporum omnium gravium, quam nullâ aliâ aquâ circumcingatur, aperta res eſt; ut patet *Newtoni* Propoſitionem attente perlegenti. Si etiam Cataracta glacie concavâ, figuræ Cataractæ aqueæ adamuſſim congruente, & propter ſummam polituram nullam reſiſtentiam adferente ambiatur; ea glaciem ne minimâ quidem vi premet, ſed tanget ſolum liberrime cadendo, unde nihil mutabitur non modo in figurâ, ſed nec etiam in velocitate Cataractæ deſcendentis. At ſi circumpoſita Glacies in aquam reſolvatur, neutiquam jam opus eſt tanto *Machinarum* & *Arietum validiſſimorum* apparatu,

ratu, quos magno molimine ‡ adduxerunt tum ipſe *Vir Cl.* tum etiam Geometra Eximius, *Johannes Bernoullius*, ad *fragilem* noſtram *Cataractam confringendam & comminuendam*; quippe quam ipſe prius *Newtonus* hiſce verbis, * *Liqueſcat jam glacies in vaſe*; &c. diſſolverit penitus ac diſſipaverit. Nullo igitur aut *Genio* nobis opus eſt, aut *Erythræi Maris Miraculo*, ad Cataractam iſtam ſive indicandam, ſive conſervandam, quippe qui non adeo uſque ſtolidi aut inſulſi ſimus, ut conſervatum iri eam ſperemus ab omni aquæ circumpoſitæ communione puram & illibatam. Ignoſcat autem nobis, pro æquitate ſuâ, Cl. *Michelottus*, quod, quæ Providentiſſimus *Newtonus* de glacie ambiente, & eâdem poſtea in aquam reſolutâ fuſius tradiderit, ea noſmet Lectorem ex ipſo potius Cl. Auctore petere voluerimus, quam ingratâ & minime nobis neceſſariâ repetitione detineri.

Non diffitemur ſane paulum diſcriminis, ut id obiter notemus, inter caſum a *Newtono* poſitum & noſtrum intereſſe. Quem enim fingit ille Cylindrum glaciei, velocitate datâ uniformi deſcendentem, ac liqueſcentem & in aquam converſum, quam primum ſuperficiem attingit aquæ vaſe contentæ, in eum ſcilicet finem, ut vas ſemper æque plenum conſervetur; hunc nos omiſimus, & ejus loco ſuperficiem aquæ infinitam poſuimus, ut eâ ratione integrum Solidum, ſive Cataractam Hyperbolicam repræſentaremus. At hæc poſitio nihil mutat neque in velocitate, nec in *Motu* aquæ decurrentis.

Quod autem † ait Vir. Cl. *me ſumere, quod eſt in contentione*, & paulo infra, *ceſſare igitur quæſtionem, & totam Demonſtrationem abire in Hypotheſin*, non mehercule intelligo, quid ſibi velit.

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‡ Pag. 128, 129, 130. * Pincip. *Pag.* 304. † *Pag.* 127.

aut

Mihi enim, in loco citato, nulla movebatur quæſtio de velocitate aquæ effluentis, nec demonſtrationem ullam de eâ velocitate adferebam, ſed id unum agebatur, ut ex poſitâ illâ velocitate Æquationem Curvæ Hyperbolicæ Newtonianæ deducerem. Velocitatem nempe aquæ effluentis jam antea determinaveram, vel etiam, ſi placet, ſumpſeram, poſitis ſcilicet iis, quæ a *Newtono* poſita fuerant, aquam nempe gravitatis vi libere cadere, & inter cadendum accelerari. Hoc autem quî fieri poſſet, prius tradiderat *Newtonus*, ponendo aquam per glaciem politiſſimam ambientem, vel etiam per eandem in aquam ſolutam, ſed quietem adhuc ſervantem, tanquam per infundibulum, ſine ullâ reſiſtentiâ tranſire ; quod in eum finem ponebatur, ut ſimplicior & magis Mathematica redderetur Problematis ſolutio.

Libet hic loci, propter argumenti affinitatem, erroris meminiſſe, cujus *Newtonum*, *Hugenium*, *Keillium* temere nimis, uti nobis videtur, ex Bernoullianæ demonſtrationis fiduciâ * incuſat *Cl. Michelottus* ; quod ſcilicet vim, quâ totus aquæ exilientis *Motus* generari poteſt, æqualem ſtatuerint ponderi Cylindricæ columnæ aquæ, cujus baſis eſt foramen, cujuſque altitudo dupla eſt altitudinis aquæ vaſe contentæ. Hanc paucis admodum verbis, nec tamen idcirco minus perſpicue, demonſtravit *Newtonus* in Corollario ſecundo Propoſitionis ſupradictæ. Potuiſſet alia quoque deduci demonſtratio ex contemplatione Cataractæ integræ Hyperbolicæ, quæ huic Cylindro æqualis eſt, cujuſque pondus totum in aquæ deſcenſum impenditur : ſed hâc minime opus eſt, cum idem ex ipsâ Propoſitione Bernoullianâ, quam toties laudat, ac tam vehementer defendit *Cl. Michelottus*, apertiſſime ſequatur. Id nullo negotio

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* Pag. 112, 113.

animadvertet *Vir Doctiſſimus*, ſi ſepoſitâ parumper Columnæ foramini incumbentis conſideratione, calculo inſtituto, ex mole aquæ dato quovis tempore ex foramine effluentis, & ex velocitate, quâcum aquam effluere ſtatuit *Cl. Bernoullius*, ejus aquæ *Motum* determinare voluerit, & deinde pondus invenire, quod eodem dato temporis ſpatio, libere cadendo gravitatis vi, eandem *Motûs* quantitatem generare poſſit. Hoc autem pondus reperiet ponderi duplæ Columnæ aquæ foramini inſiſtentis æquale, prorſus uti definivit *Newtonus* in Corollario prædicto. Idem vero pondus, alteri Libræ Radio appenſum, ab impetu aquæ, cum primum ex foramine effluit, continuato rivo in alterum Libræ æqualem Radium impingentis, atque ſtatim poſt impulſum delabentis, in quiete ſuſtinebitur ; quod poſito calculo facile patebit.

Videor mihi non malam gratiam a *Doctiſſimo Michelotto*, pro candore ſuo, initurus, ſi altero inſuper † præjudicio, quo & alios plures teneri video, ipſum liberavero. *Newtonus*, *Prop.* 37. *Lib.* 2. *Princip. primæ editionis*, aquam demonſtravit ex foramine in fundo vaſis eâ cum velocitate erumpere, quâ aſſurgere poſſit ad dimidiam altitudinem aquæ in vaſe exiſtentis. Demonſtrandi rationem nemo refellit : concluſionem plures redarguunt. Experientia, inquiunt, contradicit, quâ deprehenditur aqua exiliens ad totam altitudinem aſſurgere : quin etiam *Newtonus* ipſe in Problematis ejuſdem ſolutione, *Prop.* 36. *lib.* 2. *editionis ſecundæ*, eam tribuit aquæ velocitatem, quâ ad totam altitudinem profilire poſſit ; adeoque ipſe ſibi contradicere videtur. Atqui ſi res iſta accuratius & cum judicio perpendatur, reperietur primæ ſolutioni *Newtoniane*

† Pag. 113.

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& cum ſecundâ, & cum experientiâ ipsâ, optime convenire. Nam in ſecundâ ſolutione, aquæ venam exilientem, ad parvam a foramine diſtantiam, contractiorem diametro ſtatuit *Vir Perſpicaciſſimus*, quam in ipſo foramine, in ratione 21 ad 25. Eſt itaque ſectio venæ in eâ diſtantiâ, ad foramen ipſum, ut 21×21, ad 25×25, h. e. ut 1 ad $\sqrt{2}$ proxime. Cumque eadem aquæ quantitas, ſive per foraminis, ſive per venæ contractæ ſectionem, dato tempore perfluat, & proinde velocitates aquæ in iis ſectionibus ſint in ratione ipſarum ſectionum reciprocâ; erit velocitas in foramine ad velocitatem venæ contractæ, ut 1, ad $\sqrt{2}$: proinde, ſi ea ſit velocitas venæ contractæ, quâ aqua proſiliat ad integram altitudinem aquæ in vaſe, non major erit aquæ velocitas in ipſo foramine, quam quâ ad dimidiam altitudinem deferatur. Conſentiunt itaque inter ſe hæ duæ ſolutiones; & experientia porro cum iiſdem conſentire deprehenditur. Nam ſi per alterutram earum ſolutionum, ex definitâ velocitate, quâ aqua, ſive per foramen, ſive per venam contractam, tranſire ſtatuitur, calculo inſtituto inveniatur quantitas aquæ effluxuræ; reperietur eadem cum quantitate aquæ, quæ per experimenta effluere deprehenditur, proxime convenire. Certe experimentum ab ipſo *Illuſtriſſimo Newtono* ſumptum, adhibito foramine, cujus diameter erat quinque octavarum digiti partium, huic calculo reſpondit; ut etiam alia plura experimenta minoribus diametris *Londini* facta, quibus ipſe cum pluribus Regiæ Societatis Sodalibus, ante aliquot annos operam dedi. Abludunt quidem aliquantum *Diligentiſſimi* * *Poleni* experimenta, ſed tamen minorem aquæ quantitatem exhibent, quam ſecundum hunc calculum, nunquam majorem, forte quod anguſtiora fuerint vaſa pro ratione amplitudinis foraminum.

* Polen. de Caſtellis.

Supereſt adhuc nobis conſideranda * Animadverſio una, ſive potius Scrupulus *Viri Cl.* ex eo natus, quod in *Coroll.* 17. *Theorem.* 3. Diſſertationis prædictæ majorem ſtatuimus *Motum*, ſive *Impetum*, ſanguinis in Arteriis omnibus capillaribus ſimul ſumptis, quam in ipsâ Aortâ. Hoc ut explicet *Vir Doctiſſimus*, neſcio quam Hypotheſin nobis affingit, de majore ſanguinis denſitate in capillaribus Arteriis, quam in Aorta. Nos vero nullam ejuſmodi conditionem poſuimus, ſed Corollarium deduximus ex Theoremate præcedente, in quo agitur de *Motu* aquæ per Canalem plenum quemcunq; fluentis: unde patet ſanguinem non aliter conſiderari in noſtris Corollariis, quam quatenus fluidus eſt & aquam æmulatur. Sed patet inde provenire Scrupulum *Viri Cl.* quod per ſanguinis *Impetum* intelligat, *quantitatem Motûs ejus effectam ex multiplicatione velocitatis per maſſam dato tempore tranſluentem.* Atqui hic longe alius eſt ac noſter ſanguinis *Motus*, ſive *Impetus*, quippe qui in iſto Theoremate *æqualis* ſtatuitur *Motui molis aquæ, quæ dato quovis tempore effluit ex Canali, cujuſque ea ſit velocitas, quâ percurratur eodem dato tempore ſpatium æquale longitudini Canalis.* Facile autem ex hoc Theoremate fluit Corollarium prædictum, quippe cum dato tempore transfluat eadem ſanguinis moles per Aortam & per Arterias capillares, major autem ſit Canalis longitudo ex Aortâ & Arteriis capillaribus compoſiti, quam Aortæ ſolius. Hoc eo libentius notavi, quod videam non ſolum *Doctiſſimum Michelottum*, ſed alios etiam ſcriptores Mathematicos, pluribus in locis, ubi agitur de potentiis, quæ liquorem per Canales eodem plenos aut in motum impellunt, aut effluentem ſiſtunt, nihil aliud conſiderare præter molem

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* Pag. 101, 102.

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& velocitatem fluidi effluentis; quum debuiſſet etiam longitudinis ipſorum Canalium ratio haberi. Nam cæteris paribus, eo difficilius vel expellitur fluidum ex pleno Canali, vel in effluxu ſiſtitur, quo Canalis longior fuerit; quippe quum tota moles fluidi Canale contenti in motum concitandus ſit, priuſquam ulla pars ejuſdem effluere poſſit ex orificio; ſicuti etiam tota eadem moles neceſſario ſiſtenda eſt, ſi exitum parti jamjam effluxuræ prohibere volueris.

Accedo jam ad expendendam Viri Celeberrimi, *Johannis Bernoullii*, Demonſtrationem de velocitate aquæ ex foramine vaſis pleni effluentis. In quem finem legi diligenter ac relegi, tum quæ protulit *Doctiſſimus Michelottus* de ‡ principiis illius Demonſtrationis, tum ipſam Demonſtrationem a *Cl. Hermanno* communicatam in *Actis Lipſienſibus*, Anni 1716. Quæ quamvis nullâ ex parte mihi ſatisfaciat, tamen cum imbecillitatis meæ conſcius longe facilius accidere poſſe ſentiam, ut ipſe a vero aberrem, quam ut Virum nobiliſſimis inventis clarum, & acerrimo, ſi quis alius ingenio pollentem, erroris alicujus redarguam; cunctanter idcirco & dubitantius proponam, quid in illâ Demonſtratione minus firmum mihi videatur.

" Fundamentum Demonſtrationis (*ſcribit Vir Cl.*)
" in hoc conſiſtit, ut conſideretur guttula liquoris in-
" fima, & foramini vaſis immediate incumbens, tan-
" quam preſſa, vel (ut ego voco) animata a gravitate
" quâdam acceleratrice quæ ſe habet ad gravitatem na-
" turalem ut altitudo aquæ vel liquoris totius foramini
" vaſis incumbentis ad altitudinem guttulæ, ſcilicet ut
" pondus abſolutum columnæ aquæ foramini inſiſtentis

‡ Pag. 131.

" ad

" ad pondus abſolutum guttulæ; Sic quippe nihil aliud
" reſtat, quam ut quæratur quantam velocitatem acqui-
" rere poſſit guttula animata ab iſtâ gravitate majori
" quando cadit per lineolam ſuæ altitudini æqualem,
" hoc eſt, poſtquam tota exierit per foramen; tam diu
" enim premitur a totâ columnâ aqueâ adeoque anima-
" tur a gravitate majore quamdiu aliquid de guttulâ
" (quam ut columellam ſolidam concipio) ſupra foramen
" exiſtit."

Poſito hoc fundamento pergit *Vir Cl.* ad Demonſtrationem ſuam concinnandam: nobis vero ſuſpecta eſt ipſius fundamenti firmitudo. Ut id quo jure fiat, videatur, ita, ſi placet, procedamus.

Quoniam nullâ aliâ re utitur *Cl. Bernoullius*, ad animandam, ut vocat, guttulam infimam gravitate prædictâ acceleratrice, niſi ſolâ preſſione, ſive pondere, columnæ aqueæ foramini inſiſtentis; congelari ponatur omnis aqua columnam illam ambiens, & columna aquea per politiſſimam glaciem ſine omni reſiſtentiâ labi concipiatur. His poſitis, quamdiu foramen clauſum tenetur, urgebitur ſane guttula foramini proxima toto pondere columnæ aqueæ incumbentis, prorſus uti ſtatuit *Cl. Bernoullius*.

Reſeretur jam foramen, & permittatur liber exitus aquæ effluxuræ. Quid deinde futurum cenſes? Num urgebitur, vel *animabitur guttula infima gravitate acceleratrice, quæ ſe habet ad gravitatem naturalem, ut altitudo aquæ totius foramini incumbentis, ad altitudinem guttulæ.* Minime vero; ſed urgebitur ſolâ gravitate ſuâ acceleratrice naturali. Nam quam primum guttula infima moveri deorſum incipit, etiam velocitate, ſi placet, infinite parvâ, non amplius utique urgebitur a pondere Columnæ aqueæ inſiſtentis. Fieri enim non poteſt, ut Columna aquea guttulam ſubjectam premat, niſi ab illâ guttulâ impediatur in deſcenſu,

ſu. Non autem impeditur, quia non conatur velocius deſcendere, quam infima guttula gravitate ſuâ deorſum fertur ; ſed columna & gutta pari paſſu deſcendunt, adeo ut gutta neque columnam deſertura ſit, nec ab eâdem ullam vim aut preſſionem ſit paſſura.

Cedit itaque, ni fallor,& fatiſcit *Bernoullianæ* Demonſtrationis Fundamentum: ſed circumſpicienti mihi,quidnam potiſſimum tanto Viro occaſionem dederit a vero aberrandi, id præcipue occurrit, quod ſcilicet minus animum intenderit *Vir Acutiſſimus* ad diſcrimen, quod eſt inter corpus preſſum a pondere incumbente, quum pondus iſtud non niſi a naturali Gravitatis vi acceleratrice urgetur, & corpus impulſum, ſive *animatum* (quoniam iſto verbo uti voluit *Vir Cl.*) a Gravitatis vi acceleratrice præter naturam auctâ. In caſu poſteriore deſcendet corpus majore velocitate, quam quæ ex Gravitate naturali proficiſci queat, prorſus ex ſententiâ *Doctiſſimi Bernoullii:* at in priore, utut corpus preſſum, dum quieſcit, urgeatur a pondere incumbente, tamen ubi primum deſcendere incipiet, eâdem prorſus velocitate deſcendet, ac ſi prius nullo pondere incumbente preſſum fuiſſet.

Neſcio an operæ pretium ſit, rem per ſe ſatis claram exemplo illuſtrare.

Quieſcere ponatur in mensâ columna ſolida ex centum Aureis ſibi invicem impoſitis confecta, & urgeatur, ut fit, Aureus infimus pondere Aureorum incumbentium. Si fiat jam foramen in mensâ ſubter Aureos, ut labi ſinatur Aureus infimus: quamprimum iſte Aureus deſcendere incipiet, liberabitur ſtatim ab Aureorum incumbentium pondere, & eâdem velocitate deſcendet tum Aureus infimus, tum reliqui omnes, ac ſi ſolus ille Aureus in mensâ conſtitutus fuiſſet.

Mitto dicere, quod, ſi quis ex velocitate, quâcum aqua ſecundum *Cl. Bernoullii* placita ex foramine egreditur,

greditur, & ex determinatâ per eam velocitatem mole aquæ dato quovis tempore effluentis, *Motum* ejuſdem, ut ſupra monui, definire voluerit, eundem duplo majorem reperturus ſit, quam qui ex pondere Columnæ aqueæ foramini inſiſtentis, eodem tempore, Gravitatis vi generari queat. Profecto videntur iſta mihi tantam veri ſpeciem præ ſe ferre, ut multum debiturus ſim ſive *Cl. Michelotto*, ſive ipſi Demonſtrationis Auctori Celeberrimo, ſi me aliquid rectius docere dignabitur.

Liceat interim ipſis, pace tantorum Virorum, ſequentia duo Experimenta, ad controverſiam iſtam certius dijudicandam, vel de novo inſtituenda, vel ſaltem diligenter expendenda commendare. Alterum *Newtonianum, pag.* 305. *Princip. ſecund. Ed.* deſcriptum ; ut inveniatur, ex mole aquæ dato temporis ſpatio effluentis, velocitas, quâcum tranſit per ipſum foramen : alterum *Cl. Mariotti, Libro Du Mouvement des Eaux, Part.* 2. *Diſc.* 3. *Regl.* 1. quod tubo Cylindrico, utrinque aperto, parte inferiore ſurſum reflexo, & aquâ pleno ſumptum eſt ; unde facile æſtimari poſſit, utrum guttulæ primæ aquæ effluentis ad tantam altitudinem proſiliant, quantam requirit *Bernoulliana* Demonſtratio.

V. *An*

V. *An Account of a remarkable Inſtance of the Infection of the Small Pox. By Dr.* Jurin, *Soc. Reg. Secret.*

A Young Gentleman ill of the Small Pox, of that ſort which is call'd the cohærent, or the middle between the diſtinct and the confluent Kind, on *Wedneſday Oct.* 3d 1722, being the ſixth Day from the Eruption, grew delirious in the Night, and got out of bed in ſpite of the Oppoſition of two Nurſes that attended him; and ſeizing one of his Nurſes by the Neck with his bare Arms, he preſſed her Forehead againſt his naked Breaſt, then cover'd with the Small Pox in the State of Maturation, and held her for ſome time in that Poſture. She was heated by ſtriving with him, and in ſtruggling to get looſe, ſhe was ſenſible that ſhe bruis'd and broke ſome of the Puſtules with her Forehead. The Woman was about 40 Years of Age, of a clear, florid, ſanguine Complexion; ſhe told me ſhe had had the ſmall Pox, when ſhe was about ſeven or eight Years of Age, and had been pretty full of them, but I ſaw no Marks upon her Face. On *Friday* Morning the Small Pox began to appear upon her Forehead, and increas'd by Degrees to between 50 and 60; ſhe had likewiſe a ſmall Number of Puſtules upon the back part and ſides of her Neck, where the Gentleman had graſp'd her with his naked Arms; but had none, as ſhe told me, upon any other Part of her Body. The lower Part of her Face was perfectly clear, and thoſe upon her Forehead were chiefly confin'd to

the middle and moſt prominent Part of it, which had been preſs'd againſt the Gentleman's Breaſt. They roſe gradually, and came to Maturity, in the ſame manner as the Small Pox of the milder cohærent Kind uſe to do, with a great Inflammation and Swelling of her Forehead, and the adjoining Part of her Face, eſpecially between the Eye-brows, where a ſmall Cluſter of the Puſtules were ſeated, inſomuch that on *Tueſday* the 9th of *October*, her right Eye was quite clos'd up, and the left almoſt in the ſame Condition; but all this Time ſhe had no Fever, Sickneſs, or other Symptom of the Small Pox, beſide this Eruption, and the Inflammation, and Pain that attended it. That Night ſhe caus'd a Bliſter to be applied to her Neck, upon which ſhe recover'd the Sight of her Eye the next Day, being the ſixth from the Eruption, when the Puſtules were turning, and beginning to ſcab. The Scabs agreed with thoſe of the milder cohærent Small Pox in their Appearance and Duration. I ſaw her hitherto every day, as likewiſe at ſeveral times after this, and particularly on *Monday Oct.* 22d, which was the eighteenth Day from the Eruption of the Puſtules, when ſhe had ſtill ſome ſmall Part of the Scabs remaining upon her Forehead.

In this Inſtance it is worthy of Remark: 1ſt, That this Woman, tho' ſhe had had the Small Pox before, was yet infected again by the immediate and cloſe Application of the variolous Matter to her Skin, when her Body was heated with Exerciſe. Which ſeems to prove, that ſuch an Application is more effectual to give the Infection than the bare morbid *Effluvia*, ariſing from the Body of the ſick Perſon, and received into the ſound one by Inſpiration; for that ſhe receiv'd no Infection by Inſpiration is plain, from the appearing of the Small Pox upon thoſe Parts only where there had been ſuch an

Applica-

Application and Contact. From which it appears very probable, that a Perſon who has already had the Small Pox, as the Man inoculated by Mr. *Tanner* in St. *Thomas*'s Hoſpital, may poſſibly receive it again in ſome ſlight Degree by Inoculation; that being ſtill a more cloſe and immediate application of the Variolous Matter to the Blood and Juices of the ſound Perſon, than when it is applied only by Contact to the Skin whole and unwounded.

2dly, That the Infection communicated to this Woman not being univerſal, as appears from her having no Fever, or Sickneſs, or general Eruption of the Puſtules all over her Body, but only on the Parts infected by immediate Contact, no Argument can be drawn from hence, for a Perſon's being liable to undergo the Small Pox a ſecond time, ſo as to have the uſual Symptoms of that Diſeaſe, and a general Eruption of the Puſtules; but rather the contrary.

3dly, That the Time in which this Infection ſhew'd itſelf, by the appearance of the Puſtules, is very different from that obſerved upon Inoculation; the firſt appearing in about a Day and an half; whereas in the latter Caſe, the Eruption generally ſhews itſelf on the tenth Day, or not above a Day ſooner or later, as appears from the accurate and curious Obſervations of Dr. *Nettleton*. Which difference is what ought in reaſon to be expected, ſince in one Caſe the Infection went no further than the Parts affected by immediate Contact; whereas in the other it muſt be propagated thro' the Maſs of Blood to all Parts of the Body.

VI. *An Account of two Obſervations upon the Cataract of the Eye; contain'd in a Letter from Signor* Antonio Benevoli, *Maſter-Surgeon in the Hoſpital of* S. Maria Nuova *in* Florence, *to Dr.* Valſalva; *Printed in* Italian *at* Florence, *this preſent Year, and communicated to the* Royal Society, *at the Deſire of the Author, by Sir* Thomas Dereham, *F. R. S.*

IN this Letter the learned Author informs Signor *Valſalva*, that, on the 13th of *July* in the Year 1720. he had couch'd a *German* Soldier of Cataracts in both his Eyes, who immediately after the Operation recover'd the Sight of both Eyes, and continued to ſee till his Death, which happen'd of an Acute Illneſs on the 6th of *April* in this preſent Year. Upon this, Signor *Benevoli* took the Eyes out of their Orbits, in order to examine whether the Cataracts, which this Soldier had been couch'd of, conſiſted of a membranous Pellicle, as ſome Writers maintain; or, as others pretend, of a preternatural Opacity in the Cryſtalline Humour. Proceeding immediately to the Diſſection of the left Eye, upon a careful and very exact Examination of all the Contents of it, he could not find any ſuch thing as a Pellicle within it, but diſcover'd a ſmall yellowiſh Body at the bottom of the Bulb of the Eye, of a lenticular Shape, without Adheſion to any of the other Parts

Parts of the Eye, which, upon taking it out, appear'd to be the Cryſtalline Humour grown opake, and ſomething leſs than its natural Size, having two or three ſmall Dents, or Impreſſions, made in its Circumference, which it had received from the Needle during the Operation of couching.

The next Day he examin'd the right Eye in the ſame manner, in the Preſence of ſeveral eminent Phyſicians and Surgeons, and other curious Perſons, whom he had invited to the Demonſtration, and found in it the Cryſtalline grown opake and depreſſed in the ſame manner as the former, to the bottom of the Eye, ſtill carrying the Marks of the Needle evidently upon it, but found no Pellicle within the Eye, notwithſtanding the moſt diligent Search he could make for it. Signor *Benevoli* farther relates, that having formerly made ſome Experiments upon the Eyes of dead Subjects, at *Bologna*, in company with Dr. *Valſalva*, he had introduced the Needle into the Eye in the ſame Place, and in the ſame Manner, as is commonly practiſed in the Operation of couching, and having afterwards diſſected the ſame Eyes, he had always found, that the Needle had paſs'd into the Eye on the backſide of the Cryſtalline Humour, ſo that it had been impoſſible to bring the Needle forward from thence into that Part of the aqueous Humour, which is ſeated between the *Uvea* and the Cryſtalline Humour, in order to depreſs a Pellicle ſeated there, according to the common Opinion, unleſs he would have paſs'd his Needle thro' the Body of the Cryſtalline.

This curious Author likewiſe obſerves, that the aforeſaid Space, between the *Uvea* and the Cryſtalline Humour, is ſo very narrow, that tho' he finds it not impoſſible to introduce a Needle into that Space, yet there is by no means room enough to turn the Needle up and down in all Directions, with that Freedom,

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that

that is uſed in couching Cataracts, without wounding either the *Uvea*, or the Cryſtalline.

Laſtly, Signor *Benevoli* obſerves, that in his Practice of couching Cataracts for many Years, having generally couched about twelve or fourteen in a Year, he had always found, that he work'd upon a hard and reſiſting Subſtance, which being tenderly touch'd by the Needle, would vibrate and fluctuate backwards and forwards, and would ſometimes return againſt the Needle with a ſenſible *Impetus*, which by no means agrees with the common Notion of the Cataract's conſiſting in a Pellicle or membranous Subſtance.

FINIS.

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Jos: Banks

Numb. 374.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *November* and *December*. 1722.

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II. *The ſame Eclipſe obſerved in* Fleetſtreet, London. *By Mr.* George Graham, *F. R. S.*

III. *De Particulis & Structurâ Adamantum. Epiſtola Domini* Antonii Leeuwenhoek, *R. S. Soc. ad* Jacobum Jurin, *M. D. R. S. Secret.*

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ERRATUM.

Pag. 204. lin. *penult.* read, in icone 7.

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h	′	″	
1	29	16	Eclipſin jam inceptam vidi.
1	31	6	Diſtantia Cuſpidum 7′ 4″, unde pars deficiens 0′ 47″ ac initium verum 1ʰ 28′ 58″
1	34	18	Diſtantia Cuſpidum 10′ 50″
1	42	28	Repet. 16′ 20″
1	43	26	Inclinatio Cuſpidum ad dextras 44° 30′
2	32	37	Partes Lucidæ reſiduæ 17′ 20″
2	40	16	Repet. in med. Eclipſis proxime. 17′ 9″
3	28	45	Inclinatio ad ſiniſtras 19° 0′
3	31	45	Diſtantia Cuſpidum 15′ 21″
3	37	35	Repet. 10′ 50″
3	43	25	Finis Eclipſeos dubius, ob limbum Solis aſperum & undulantem, nec ſat bene definitum.
3	43	45	Certe deſierat Eclipſis.

Cœlum toto tempore ſerenum & tranquillum.

II. *The ſame Eclipſe obſerved in* Fleetſtreet, London. *By Mr.* George Graham, *F. R. S.*

	h	*l*	*ll*	
P. M.	1	28	38	Beginning. Apparent Time.
	2	29	34	By Eſtimation the Cuſpes Parallel to
	3	43	22	The End. (the Horizon.
	2	14	44	The Duration.

Quantity eclipſed 5 Dig. $\frac{716}{1000}$

I Had very correct Obſervations both of the Sun and Stars, the 26, 27, and 28th, for determining the exact Time by my Clock.

For ſome Minutes before the Eclipſe began, I obſerv'd the Sun with a Teleſcope of 12 Foot, furniſhed with a Micrometer; keeping that Part of the Limb in the middle of the Glaſs, where I expected the Moon firſt to touch, and in leſs than four Seconds of Time, from the Moment I judged the Eclipſe begun, it was ſo conſiderably advanc'd, that I cannot doubt of having the Beginning to leſs than three Seconds. I believe the exact Time of ending was within the ſame Limit, notwithſtanding that the Undulation of the Limb was then much greater than at the Beginning. The Parts eclipſed, meaſured with the Micrometer, at the Time of the greateſt Obſcuration, were 927 ſuch Parts as the Sun's Vertical Diameter contained 1946; which was taken a little before the Beginning of the Eclipſe.

The Sky was clear, and free from Clouds, till near the End, when a narrow one obſcured ſome part of the Sun's Disk, but that part of the Limb where the Eclipſe ended, continued clear till after it was over.

By

FIG. I.

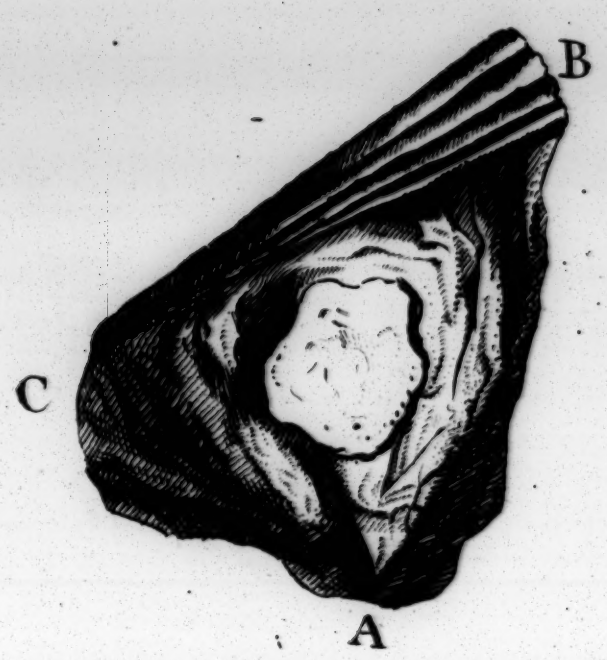


FIG. II.



FIG. III.

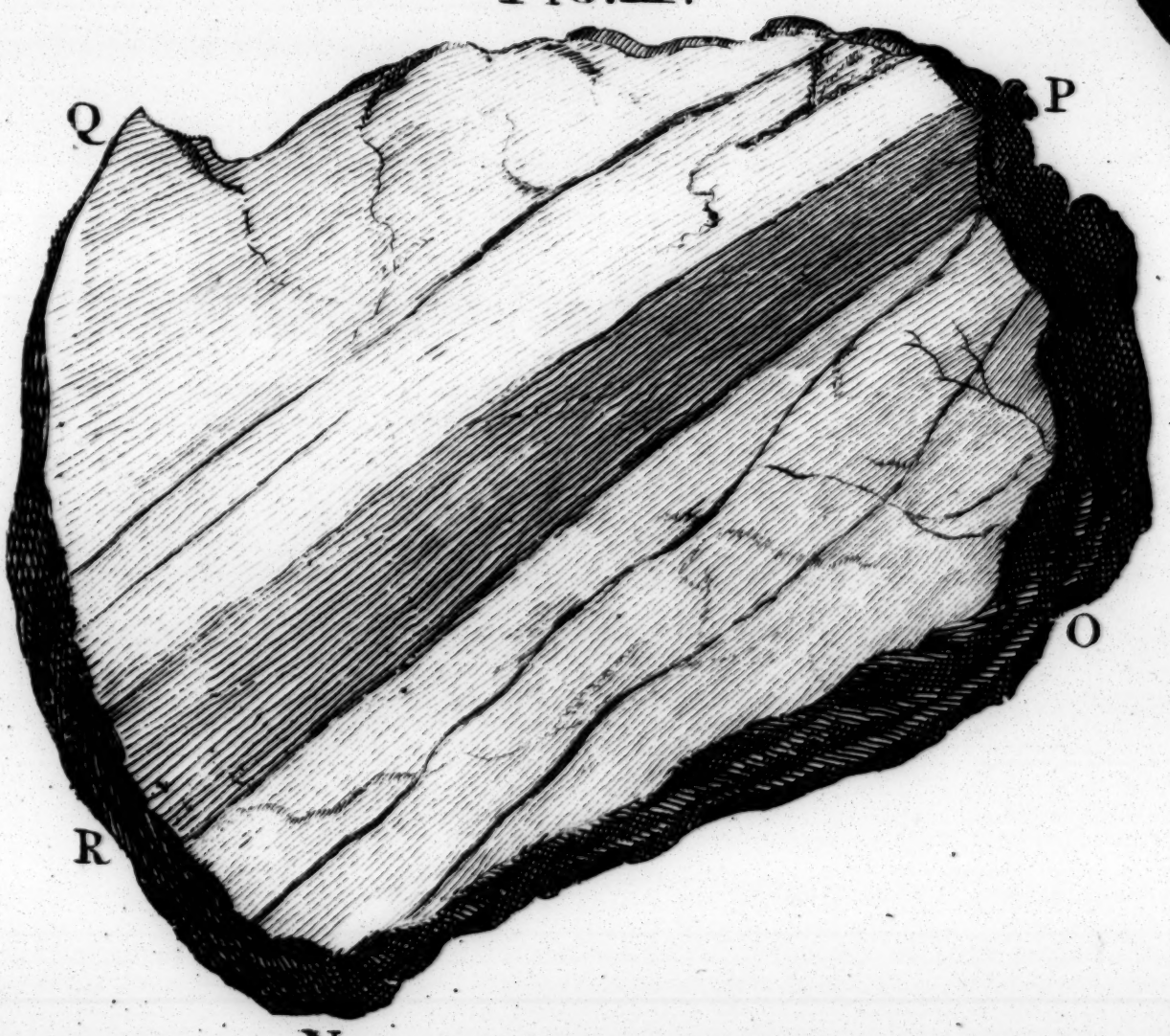


FIG. IV.

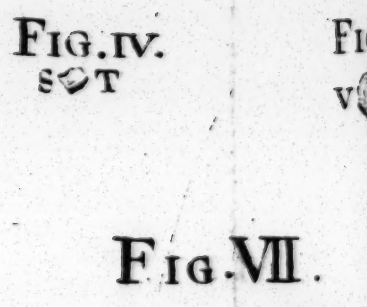


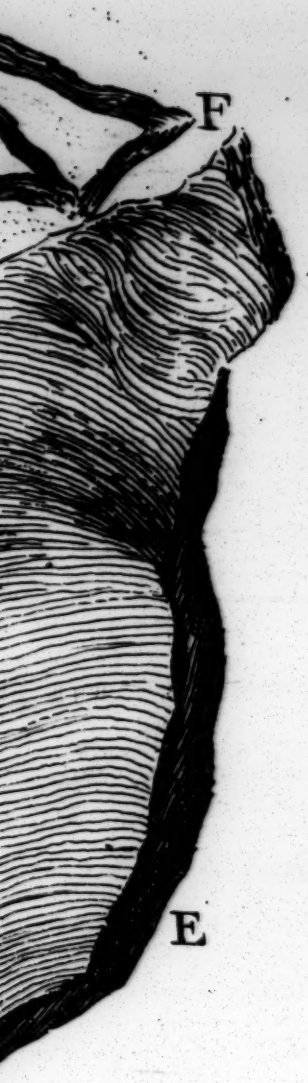
FIG. V.



FIG. VII.







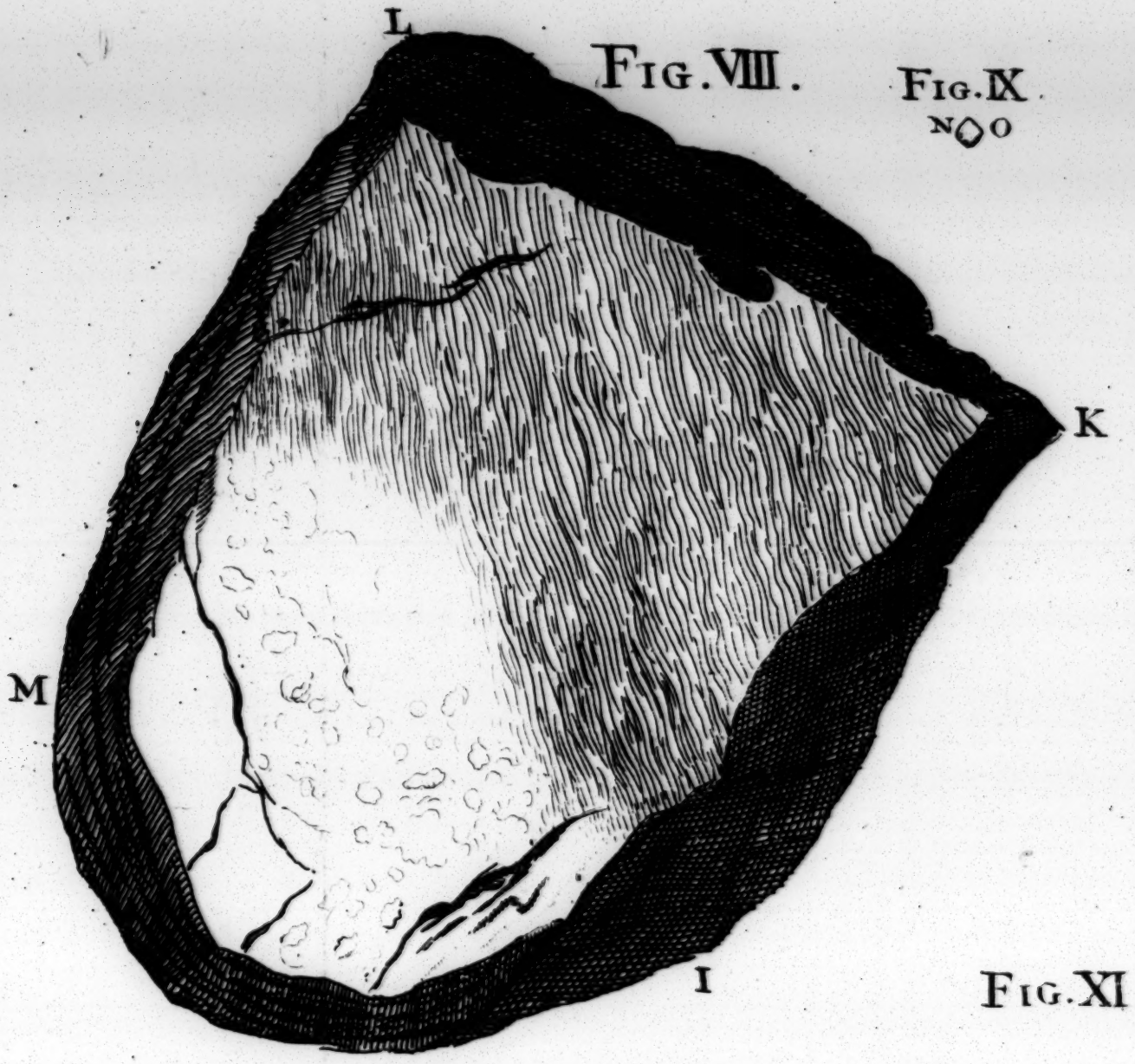


FIG. VIII.

FIG. IX.



FIG. X.

FIG. XI.

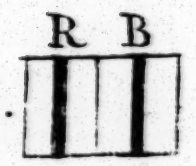


FIG. VI.



FIG. XII.

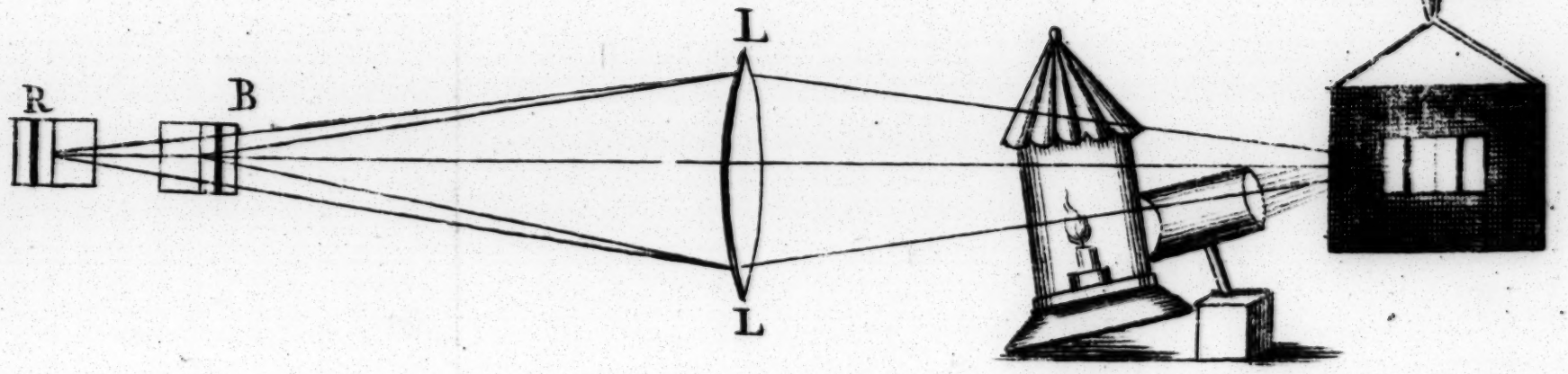
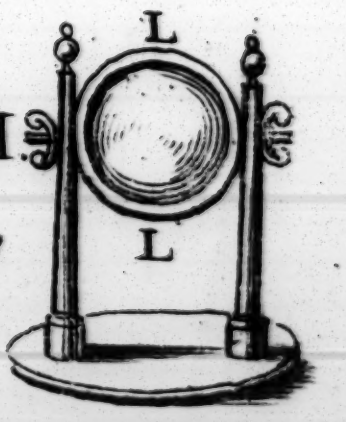


FIG. XIII.



J Sturt. sculp.

BRITISH MUSEUM

By this Obſervation the Beginning differed not 2 ′ ′ ′ ′ ′ ′ ′ ′ ′ ′ ′ ′, and the End not ′ ′ a Minute from Dr. *Halley*'s Computation, which he ſent me the Day before. And if his Computation, which was made for *Greenwich*, had been reduced to the Meridian of *London*, the Difference would have been ſtill leſs.

The ſame Eclipſe was obſerv'd by Mr. Hawkins *at* Wakefield, *in* Yorkſhire, *to begin at* 1 h. 21 m. p. m. *and to end at* 3 h. 30 m. 3 ″. *The Sun's Diameter was obſcured ſomewhat more than* 5 *Digits.*

III. *De Particulis & Structurâ Adamantum. Epiſtola Domini* Antonii Leeuwenhoek, *R. S. Soc. ad* Jacobum Jurin, *M. D. R. S. Secret.*

POſtquam inveſtigando compereram Metalla quædam, & ipſas etiam Arenas ex perexiguis ejuſdem materiæ particulis compoſitas eſſe, meditationem meam converti ad Adamantem; ſcilicet num ille etiam ex iſtiuſmodi conſtet particulis, quæ quidem ope microſcopii conſpici poſſint.

Igitur exiguum quendam Adamantem per microſcopium contemplatus, in eâ Adamantis parte quæ polita non erat, & ſplendore carebat, complures particulas oculis obſervavi; & Adamantem ex parvis particulis compoſitum eſſe comperi. Verum cum hæc nondum mihi ſatisfacerent; Adamantem in fruſta confringere decrevi, ut illum in fragmentis ſuis conſiderarem.

Ergo Adamantem, malleo impoſitum, alio malleo ſemel iterumque percuſſi, qui ſic percuſſus in quatuor aut quinque fruſta diſſiliebat. Quod cum nondum mihi ſatisfaceret, & Adamantem in exiguiſſimas miculas comminuere vellem; fruſtum, quod cæteris majus

erat, duplici chartâ circumvolvi, ne quæ Adamantis miculæ diſſiliendo perirent.

Hic ego duritiem Adamantis admiratus ſum: qui multâ vi aliquoties ictus, in quatuor tantum aut quinque fruſta ſine ullis miculis diſſiliebat—

Poſteriora iſta Adamantis fruſtula microſcopio etiam admovi: quæ cum perſpecularer, pene omnia ex minutiſſimis particulis compoſita eſſe comperi. Cum autem fruſtula illa radiis ſolaribus objicerem: quandam quaſi flammulam ex iis emicare videbam, & quidem majorem, quam unquam vidiſſem.

Fruſtulum unum oculis notabam, quod locum fracturæ ſuæ, planæ quidem ac quadratæ, ſoli directe oppoſitum habebat: qui locus, quantum viſu dijudicabam, tribus aut quatuor pilis menti virilis latitudine reſpondebat.

Ex hoc Adamantis fruſtulo tanta aſcendebat copia ardeſcentium flammularum, ut plures eſſe numero quam quadringentas judicarem. Flammularum iſtarum nonnullæ, ſed numero paucæ, ſibi erant vicinius junctæ, & reliquis majores: unde concludebam, ipſas Adamantis particulas illic etiam aliis particulis majores eſſe, vel ordinatius eſſe diſpoſitas.

Exinde oculos converti ad aliud Adamantis fruſtulum, paris circiter magnitudinis cum priori, quod radios ſolares itidem directe excipiebat; & haud pauciores exiguiſſimæ molis particulis conſtare comperiebam. Ex unâ fruſtuli illius parte eâque circiter dimidiatâ, ſpecies illæ ardeſcentium flammularum etiam exoriebantur, ſed mole minores: in altera medietate flammula quædam cernebatur, aſſidue ſe mobilitans, cum continuâ quadam coruſcatione, quæ ſpeciem habebat debilioris fulgetri.

Cæterum, poſtquam iſta Adamantis fruſtula radiis ſolaribus ſubduxeram, adhuc multiformes rerum ſpecies

cies oculis meis objiciebantur. Inter alia, ex ſingulis Adamantis particulis flammula quædam in altum emicare videbatur.

Porro, novem præterea Adamantis fruſtula microſcopio applicata habebam: & in eorum ſeptem particulas illas agnovi, quas ſpeciem flammularum ejaculari dixi. In duobus aliis etiam particulas illas agnoſcere poteram, ex quibus Adamantem compoſitum eſſe ſtatui: ſed illæ planitiem ſuam ita ſoli obverſam habebant, ut plures eodem tempore particulas dignoſcerem.

Mihi autem peramænum erat ſpectaculum, tot intueri imagines flammularum, quæ omnes colorem præferebant coruſcum, & pleræque viridantem. Iſtud autem inſolens mihi viſum eſt, quod ad flammularum quarundam extremitatem talis perciperetur in aere motus ac vibratio; tamquam ſi flammula adeo illic debilitata foret, ut conſpicua eſſe deſineret. Præ cæteris autem admirabar, quod ex tali Adamantis particulâ circumquaque ignis exiret, debiliter rutilans, ſicuti cum fulmen e longinquo coruſcare videmus. Quod quidem tam crebro intuente me accidebat, ut oculos avertere non poſſem, niſi jam fatigatos.

Verum tam jucundo ſpectaculo ſæpius frui decrevi, & fruſtulum iſtud Adamantis, donec ſponte a vitro decidat, microſcopio applicatum relinquere. Neque enim ope glutinoſæ alicujus materiæ affixum eſt vitro: niſi quod vitrum, antequam illi fruſtum Adamantis affigerem, humore anhelitus mei irroraſſem.

Cum tam grato ſpectaculo ſolus frui non vellem; quæ modo relata ſunt, legenda tradidi cuidam N. cui & microſcopium in manus tradidi. Cumque poſt aliquantum moræ requirerem; nonne omnia deſcriptioni meæ convenire comperiret; ille prorſus convenire reſpondit, & admirationem ſuum ſuper ſpectaculi inſolentiâ confeſſus eſt.

Porro,

Porro, cum fruſtulum quoddam Adamantis adhuc microſcopio applicatum eſſet, cujus particulas, lamellarum modo ſibi incumbentes, viſu dignoſcere poteram ; haud abs re me facturum putavi, ſi lamellas iſtas delineari curarem, quæ hic in icone 1 denotantur per A B C.

Deinde & aliud Adamantis fragmentum microſcopio applicaveram, cujus lamellæ, invicem ſuperſtratæ, ſeſe oculis meis diſtinctiſſime offerebant ; quæ hic in icone 2 deſignantur per D E F G H I K L M. In hac autem figurâ particulæ illæ ſive lamellæ, quæ per F G, F H, F I, F K, & L denotatæ ſunt, reliquis aliquanto craſſiores eſſe videntur : verum iſtæ particulæ ex pluribus lamellis, invicem ſuperſtratis, ſunt compoſitæ. In iſtâ vero fragmenti parte, quam inter D E F M exprimendam curavi, diſtinctiſſime apparent tenuiſſimæ lamellæ, ex quarum congerie totum Adamantem concretum eſſe pro certo habendum eſt.

Priuſquam ſecundam iconem in chartâ exprimendam curaveram ; forte celebris Gemmarius, *N. Verbrugge*, ædes meas præteribat, quem ego ad conviſendum Adamantis fragmen, ſicut microſcopio applicatum erat, invitavi. Ille fragmen iſtud non ſine admiratione contemplatus, quaſdam ſe Adamantum glebulas, quæ ſibi inutiles eſſent, mihi miſſurum recepit.

Nec multo poſt bina mihi mittit Adamantum fragmenta : item exiguum Adamantem, ex arte quidem politum, ſed ſordidum, uti vocant, ſeu vitioſum.

Cum ſingula ſingulis microſcopiis applicaſſem, primo fragmentum iſtud, quod in *Fig.* 3. per N O P Q R denotatum eſt, delineandum curavi. Lineolæ, quæ per totum hoc fragmentum excurrunt, revera non ſunt niſi lamellæ, ex quibus Adamantes conſtare modo dixi : & apertius conſpiciendas ſe præbent ad P Q.

Ceterum

Cæterum ut eorum, quæ de hâc Adamantis glebulâ, ſive fruſtulo, jam dixi, clarior atque diſtinctior ſit perceptio; fruſtulum iſtud eâdem prorſus magnitudine exprimi juſſi, quam nudo delineatoris oculo, ſine microſcopii ope, offerebat: quæ vera fruſtuli magnitudo, in icone 4, exhibetur inter S T. Iſtud autem tantillum fruſtulum ex tam multis tamque exiguis particulis compoſitum eſt; ut qui non viderit, capere haud poſſit.

In altero Adamantis fragmento, quod ejuſdem propemodum magnitudinis erat, lamellæ dignoſci poterant: & pars illius circiter quinta conſtabat quinquangulo tam polito, tamquam ſi ex arte lævigatum fuiſſet, niſi quod illi affixus eſſet perexiguus Adamas, qui circiter quartam quinquanguli partem obtegebat; & uti clare viſu agnoſcebam, etiam ex lamellis, ſive particulis lamellarum formam habentibus, concretus erat.

Quantum ad perexiguum iſtum Adamantem; illum quidem ex arte politum, ſed ſordidum ſeu vitioſum eſſe dixi: ſordidos enim vocamus, dum vel ſubflavi ſunt, vel rimis aut lineolis deformes: quamvis nonnullæ hujus Adamantis rimæ atque lineolæ nudis oculis conſpici non poſſent; imo, adhibito etiam microſcopio, viſum pene effugerent.

Exiguus hic Adamas erat quadrangulus: prope unum iſtorum angulorum, intra ipſum Adamantem, varias vidi particulas ab invicem ſejunctas; niſi quod aliquantulum ſeſe attingere viderentur, quod initio inſolens mihi viſum eſt. Particularum iſtarum maxima coloris erat ſubflavi, & altero circiter latior quam craſſior: nec ſplendore cedebat vitro. Reliquis particulis variæ erant figuræ; nonnullis etiam par ſplendor ac primæ: nec pauciores eſſe judicabam quam viginti; licet delineator tantum numerum non expreſſerit.

Iſte

Iſte conſpectus hanc mihi perſuaſionem induxit; quo tempore materia, Adamantum productrix, vagabatur in aëre; exiguas illas particulas, quæ itidem Adamantes erant, priori quem dixi Adamanti adjacuiſſe: materiam autem adamantinam, quamdiu talis materia aëri inſedit, iſtam Adamantum congeriem paulatim circumveſtiiſſe, & minores Adamantes incluſiſſe majori.

Qua occaſione recordor complures me habuiſſe Cryſtallos montanas figuræ ſexangulæ: in quarum nonnullis quaſi incluſæ jacebant figuræ quædam perexiguæ & oblongæ, coloris ſubcœrulei; ſed tam exiles ut, adhibito etiam optimæ notæ microſcopio, vix agnoſci poſſent.

Porro iſtius Adamantis, quem vitioſum appellavi, veram magnitudinem delineari curavi: quam in icone 5 expreſſam habes inter V & W.

Deinde & perexiguos iſtos Adamantes, qui in majorem Adamantem incluſi exhibentur in icone 5, ſeorſum delineandos curavi; quos in icone 6 deſignatos vides per X Y Z A B C. Ubi per X Y Z denotatur exterius Adamantis latus, quod licet ex arte politum, ope tamen microſcopii conſpectum, colorem tam fuſcum præferebat.

Per Z A B C D E iſti denotantur exiliſſimi Adamantes; quos in majuſculo Adamante velut incluſos latuiſſe præmonui.

Cum poſtea latus Adamantis in icone 5 expreſſi, cui longe minores Adamantes incluſos fuiſſe mox dicebam, ad microſcopium admoviſſem, Adamantem iſtum variis foraminibus pertuſum eſſe comperi; quæ ego foramina tunc facta eſſe cenſui, quando latus illud poliebatur. Ita nimirum ut exiguiſſimi, quos dixi, Adamantes loca illa prius inſederint, ſed poliendo delapſi foramina illa ſive puteolos produxerint, quæ foramina in icone 5 conſpicua ſunt inter F G H.

Porro

Porrro exiguum illum Adamantem, inter V W in icone 5 expreſſum, in latus ſuum verteram ; & ubi craſſiuſculus erat, novaculum illi aptaveram, ut Adamantem ipſum ictu mallei diffinderem : quod tamen, licet iterato tentanti, non ſucceſſit.

Quare Adamantem chartâ mundâ circumvolutum, imponebam malleo ; & alio malleo, crebrius tamen feriendo, diffregi. Poſtquam omnes diffracti Adamantis glebulas diverſis microſcopiis applicaveram ; unam, quæ plures qam reliquæ lamellas oculis exhibere videbatur, delineatori effingendam tradidi, quæ in icone 8 denotatur per I K L M. Haud tamen poſſibile delineatori fuit eâdem perfectione glebulam illam exprimere, quâ ſeſe oculis conſpiciendam offerebat.

Cum autem microſcopium, cui fruſtulum illud iconis 8 applicatum erat, diverſum eſſet ab iis microſcopiis, quorum ope alia Adamantis fruſta delineari curaveram; Delineator poſtremum hoc fruſtulum eâ magnitudine expreſſit, quam ſine microſcopio conſpectum oculis offerebat : quæ vero fruſtuli illius magnitudo in icone 9 exhibetur inter N O.

Quædam ex his Adamentum fragmentis, ope microſcopii conſiderata, jucundos præbebant conſpectus : quos etiam nonnullis, talium rerum ſtudioſis, exhibui. Illis autem jucundiſſimum erat, in uno Adamantis fruſtulo tam multiplices agnoſcere partes : imprimis etiam quod lamellæ, ex quibus Adamantes concreti ſunt, in duobus Adamantum fruſtulis valde diſtincte poſſent internoſci ; nempe dum lamellæ iſtæ juxta ductum longitudinis oculis objiciebantur.

Exinde ſtudium meum converti ad examen Cryſtalli cujuſdam montanæ, ſex lateribus prædítæ, cujus longitudo circiter reſpondebat latitudini duorum digitorum, craſſitudo vero minori digito.

Cryſtallum iſtam in complura fruſta confregi, & fruſta microſcopiis applicavi; diſquirere volens num & illa ex ſuperſtratis ſibi lamellis compoſita eſſent: quâ ratione Adamantes magnitudinem ſuam adeptos eſſe dixi. Sed, tametſi perquiſitionem iſtam ſæpius iteraverim, ne tantillam quidem lamellam in iis deprehendi. Iſtud autem in Cryſtallis, quas quidem præ manibus habebam, plerumque animadverti, in omnibus earum lateribus, quæ numero ſena erant, tranſverſas protendi lineolas, alias aliis ſitu aliquantulum ſuperiores; tamquam ſi illic, increſcentibus Cryſtallis, ortæ productæque fuiſſent: quâ ſuper re, quantumcumque Cryſtallorum numerum ante conſideraverim, atque confregerim, numquam ipſe mihi ſatisfacere potui.

Delphis in Hollandiâ,
Nov. 20. 1722.

IV. *An Account of an Optical Experiment made before the* Royal Society, *on* Thurſday, Dec. 6th, *and repeated on the* 13th, 1722. *By the Reverend* J. T. Deſaguliers, *L. L. D. F. R. S.*

SIR *Iſaac Newton*, in his Optics, (*B.* 1. *Prop.* 1. *Exp.* 2.) relates an Experiment made with a Card, or Paper, painted red on one half and blue on the other, which being enlighten'd by a Candle, the Image, by the Interpoſition of a *Lens*, is ſo projected on a white Paper, held on the other ſide of the *Lens*, that the Place where the blue half appears diſtinct, (or as the Opticians term it, the diſtinct Baſe of the Image of the blue half) is much nearer to the *Lens* than the Place of the Image of the red half. And this is made apparent

apparent, by ſeeing on one of theſe Images the Repreſentation of the black Threads, that are wrapp'd round the Card, whilſt they are not viſible on the other. This is fully deſcribed in the Place abovemention'd; but yet a * Gentleman abroad has call'd the Experiment in queſtion, and denied the matter of Fact, ſaying, that he could not make it ſucceed, but propoſes an Experiment of his own to diſprove the different Refrangibility of the Rays.

Upon this I was deſir'd to make the Experiment over again, before the Royal Society, which ſucceeded well. But becauſe there muſt be care taken in the making it, I ſhall mention all the Particulars obſerved in the Performance; which, if duly put in practice, will make the Experiment always ſucceed.

I painted one half of the Card R B, (*Fig.* X.) as B, with *Ultramarine*, made deeper with a ſmall Mixture of *Indigo*, and the other half R, I painted over with *Cinnabar* heighten'd with a little *Carmine*, ſo that the Line, that ſeparated the red from the blue, was perpendicular to the long ſides of the Cord.

Then I wrapp'd a black Silk four times together, over the middle of each painted part of the Card, as in *Fig.* XI.

Upon a ſquare Trencher, *Fig.* XII. painted black, and ſuſpended vertically againſt a Wall, I fix'd my colour'd Card with a Pin, and the Room being made very dark, I enlighten'd the Card with a ſtrong Light thrown upon it from a dark Lanthorn, that had two Convex Glaſſes in it; then ſetting up the *Lens* L L, (repreſented by *Fig.* XIII.) in ſuch manner, that its Axis paſs'd perpendicularly thro' the Image of the Card, at

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* Act. Erudit. Lipſ. Supplem. tom. 8. §. 3. p. 130. 131.

the distance of nine Feet from the Card, the Image of the Card being receiv'd upon a white Paper, at the distance of nine Feet on the other side of the *Lens*, at B, the blue half appear'd distinct, with the Image of the black Silk going vertically along its Plain, whilst no Appearance of the black Silk was perceivable on the red half. Then removing the Paper about two Inches, to R, the red half of the Image had a black Line very plain upon it, whilst it was invisible on the blue half. This was more evident, when a strong Image of the Candle was successively thrown on that half of the Card, whose Image was under Examination. When the Paper was held in the middle between R and B, the black Line upon each Colour was visible, but indistinct.

N. B. Care must be taken that the Colours be deep, because having accidentally rubb'd off some of the blue, the Whiteness of the Card under it, made its Image fly out farther, almost as far as that of the red.

V. *Part of a Letter from Dr.* Nettleton, *Phyſician at* Halifax, *to Dr.* Jurin, *R. S. Secr. concerning the* Inoculation of the Small Pox, *and the Mortality of that Diſtemper in the natural Way.*

THERE are two Propoſitions advanced by the Favourers of the Practice of Inoculation, concerning which the Publick ſeems to require more full Satisfaction. *That the Diſtemper rais'd by Inoculation is really the Small Pox*; and, *That it is much more mild and favourable, and far leſs mortal, than the natural ſort.*

The former of theſe is not ſo much diſputed now, as it was at firſt, when this Method was introduced, nor can it be made a doubt of by any one, who has ſeen thoſe that have been inoculated, and has alſo been much converſant in the natural Small Pox. There is uſually no manner of difference to be obſerved betwixt the one ſort and the other, when the Number of Puſtules is nearly the ſame; but in both there are almoſt infinite Degrees of the Diſtemper, according to the difference of that Number. All the Variation that can be perceived of the Ingrafted Small Pox from the Natural, is, that in the former the Puſtules are commonly fewer in Number, and all the reſt of the Symptoms are in the ſame Proportion more favourable. They exactly reſemble what we call the Diſtinct Sort: the Symptoms before the Eruption are the very ſame, and when the Puſtules begin to riſe, their Appearance is the ſame, as well as their Periods of Maturation and Declenſion; they are at firſt of the ſame florid, roſy Colour, and when fully ripe, of as

fair a yellow. They commonly riſe as round and as large as the other, and when they are very numerous, the Inflammation and ſwelling of the Face comes on at the uſual Time, and is followed by the ſwelling of the Hands and Feet, and only once I obſerved a Salivation, tho' the Puſtules were diſtinct. In the Natural Small Pox, when the Puſtules are very few, we ſometimes obſerve, they do not riſe to ſo great a Bulk, neither do they ripen ſo fully, nor continue ſo long as uſual; and it is the ſame in the way of Inoculation. In ſhort, as this Diſtemper is raiſed by an Ingraftment from the Small Pox, as it has the very ſame Appearance, and as it is capable of producing the ſame by Infection, there ſeems to be no room to doubt of its being the true and genuine Small Pox. And if that be allowed, it will follow from thence, as a Corollary, that *Thoſe, who have been inoculated, are in no more Danger of receiving the Diſtemper again, than Thoſe who have had it in the ordinary Way.* And this is alſo thus far confirmed by Experience. We are very ready to own, that the Operation may ſometimes fail: thoſe Gentlemen, who firſt communicated to the Royal Society ſome Account of this Practice from *Turkey*, did both of them intimate ſo much; tho' I believe that will but rarely happen. In one * Inſtance here, I obſerved no Eruption at all, neither did the Wounds inflame and ſwell any more than would have follow'd from a common Inciſion, which made me conclude, that what was apply'd had not taken Effect, and indeed the Reaſon of it was very well known to me. In three others, tho' the Wounds did inflame, and ſwell, and diſcharge conſiderably, yet the Eruptions were ſo imperfect, as to leave me a little

* *William Clark*'s Son. See Philoſoph. Tranſact. No. 370. p. 45.

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in doubt: but two of theſe have ſince been ſufficiently try'd, by being conſtantly with thoſe who had the Small Pox, without receiving any Infection; which makes me inclined to believe they will always be ſecure from any danger of it. As to all the reſt, neither I nor any body elſe, who ſaw them, did in the leaſt queſtion, but that they had the true Small Pox.

As to the latter Propoſition, *That the Ingrafted Small Pox is far leſs dangerous than the Natural:* the Truth of this, I ſuppoſe, can only be found by making a Compariſon, ſo far as our Experience will extend. In order to this, I have taken an Account in this Town, and ſome Part of the Country, and have procured the ſame from ſeveral other Towns hereabouts, where the Small Pox has been Epidemical this laſt Year, with as much Exactneſs as was poſſible, how many have had the Small Pox, and how many out of that Number have died. Some of theſe I did ſend you the laſt Summer, but I will beg leave to repeat them amongſt the reſt, that they may be all under one view.

	Have had the Small Pox.	Died.
In *Halifax* — — — — — —	276 — —	43
In a Part of the Pariſh of *Halifax*, ſtretching towards *Bradford* — — —	297 — —	59
In another Part of the ſame Pariſh —	268 — —	28
In *Bradford* — — — — — —	129 — —	36
In *Leeds* — — — — — — —	792 — —	189
In *Wakefield* — — — — — —	418 — —	57
In *Rochdale* — — — — — — —	177 — —	38
In *Aſhton under Line*, a ſmall Market-Town in *Lancaſhire*, including two neighbouring Villages — — —	279 — —	56
In *Macclesfield* — — — — — —	302 — —	37
In *Stockport* — — — — — —	287 — —	73
In *Hatherfield* — — — — — —	180 — —	20
Total	3405 — —	636

I am very ſenſible you will require a great number of Obſervations, before you can draw any certain Concluſions. I would only crave leave to remark, that it appears from theſe Accounts, that this laſt Year, in this Part of the Kingdom, almoſt nineteen out of every hundred, or *near one fifth of thoſe, who have had the natural Small Pox, have died*; whereas *out of ſixty one which have been inoculated hereabouts, not one has died*; for as to the Caſe of Mr. *John Symſon*'s Daughter, which would have made the ſixty ſecond, I leave it out of my Account, and I will refer it to any impartial Judgment, whether I may not juſtly do ſo *. The Facts are open to every one's Enquiry, and whoever will give himſelf the Trouble, may be ſatisfied as to the Truth of them.

Halifax, Dec. 16.
1722.

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* See Philoſoph. Tranſact. *No.* 370. p. 41, 42.

VI. *A Letter to the Learned Dr.* Caleb Cotesworth, *F. R. S. of the College of Physicians,* London, *and Physician to St.* Thomas's *Hospital; containing a Comparison between the Danger of the Natural* Small Pox, *and of that given by Inoculation. By* James Jurin, *M. D. R. S. Secret.*

SIR,

THE sincere and disinterested Regard for the Good of Mankind, which you have always manifested, as well in your extensive private Practice, as in that publick Post, which you have so long and so usefully fill'd, must affect you, I am sure, with a great and sensible Concern for the Destruction made among us by that terrible Calamity the Small Pox. We have seen, for some considerable Time past, above 100 Persons *per* Week in this City and Suburbs, taking one Week with another, to be carry'd off by this Disease; a Consideration certainly that ought to dispose us to enter into any Measures, by which we may reasonably hope to put some Stop to the Progress of so cruel a Distemper.

To this Purpose, Sir, the Method of Inoculation, which has lately been introduced among us, is strongly recommended on the one hand, and has been opposed with a great deal of Warmth and Zeal on the other.

I have no Inclination to enter into this Controverſy; it is in better and abler Hands: but, as the Point in Diſpute is of the utmoſt Importance to Mankind, I heartily wiſh, that, without Paſſion, Prejudice, or private Views, it may be fairly and maturely examin'd. In order to which, if the following Extracts and Computations, concerning the comparative Danger of the Inoculated and Natural Small Pox, may be of any Uſe to your ſelf, or to other impartial and diſintereſted Judges, I ſhall think my Labour well beſtowed.

The Number of Perſons, who have had the Small Pox by Inoculation here in *England*, is, by the beſt Information I have been able to collect, as follows.

Inoculated by

Dr. *Nettleton*	61
Claudius Amyand, Eſq; Serjeant Surgeon	17
Mr. *Maitland*, Surgeon	57
Dr. *Dover*	4
Mr. *Weymiſh*, Surgeon	3
The Reverend Mr. *Johnſon*	3
Dr. *Brady*, at *Portſmouth*	4
Mr. *Smith*, Surgeon, and Mr. *Dymer*, Apothecary, at *Chicheſter*	13
Mr. *Waller*, Apothecary at *Goſport*	3
A Woman at *Leiceſter*	8
Dr. *Williams* at *Haverford Weſt*	6
Two other Perſons near the ſame Place	2
Dr. *French*, at *Briſtol*	1
In all —	182

Out of this Number the Oppoſers of Inoculation affirm, that two Perſons died of the Inoculated Small Pox; the Favourers of this Practice maintain, that their Death was occaſioned by other Cauſes. If, to avoid diſpute,

diſpute, theſe two be allow'd to have died of Inoculation, we muſt eſtimate the hazard of dying of the Inoculated Small Pox, as far as can be collected from our own Experience, to be that of 2 out of 182, or one out of 91.

The Reverend Mr. *Mather*, in a Letter dated *March* 10. 1721. from *Boſton* in *New England*, gives an Account, That *of near* 300 *inoculated there*, 5 *or* 6 *died upon it or after it, but from other Diſeaſes and Accidents, chiefly from having taken the Infection in the common way by Inſpiration, before it could be given them in this way of Tranſplantation.*

If, as we have done before, to avoid all occaſion of diſpute, we allow 5 out of theſe 300 to have died of the Small Pox by Inoculation, notwithſtanding what Mr. *Mather* has ſaid of their dying by other Accidents or Diſeaſes; the hazard of Inoculation will thence be determin'd to be that of 1 in about 60. But here it muſt be obſerv'd, that by all the Accounts from *New England*, the Operators there appear not to have been ſo cautious in the choice of their Subjects, as here in *England*. For Mr. *Mather* tells us, that the Perſons inoculated were *young and old, from* 1 *Year to* 70, *weak and ſtrong*; and by other relations we are inform'd, that *Women with Child, and others even in Childbed*, underwent the Operation. Apparently the Greatneſs of the Danger they were in, from the Infection in the natural Way, which then raged among them with the utmoſt Fury, made them the more adventurous.

We come now, Sir, to the ſecond Part of our Deſign, which is to form an Eſtimate of the Hazard, which all Mankind, one with another, are under of dying of the natural Small Pox, that, by comparing this with the Hazard of Inoculation, the Publick may

be enabled to form a Judgment, whether or no the Practice of Inoculation tends to the Preſervation of Mankind, by leſſening the Danger to which they are otherwiſe liable.

With this View I have conſulted the Yearly Bills of Mortality, as far back as the Year 1667, being the Year after the Plague and the Fire of *London*, comprehending to the preſent Time the Space of 56 Years, from 42 of which I have given Extracts in the two following Tables.

The firſt of theſe takes in the firſt 20 Years, diſtinguiſhing for every Year the total Number of Burials, and likewiſe the Number that died of the Small Pox, in two ſeparate Columns. The third Column ſhews, how many died of the Small Pox out of every Thouſand that were buried; and the fourth Column repreſents the Proportion between thoſe that died of the Small Pox, and the whole Number of Burials, by the neareſt Vulgar Fraction, having always 1 for the Numerator.

The ſecond Table gives the laſt 22 Years, after the ſame manner, and at the bottom of each Table is given the Total Number for each Series of Years, and likewiſe the Number that died each Year, taken at a Medium, one Year with another: by which it appears, that the Proportion between the Number of thoſe that die of the Small Pox, and the whole Number of Burials, is very nearly the ſame, upon an Average for each Series of Years.

The 14 intermediate Years between 1686 and 1701 are left out, becauſe in the Bills for thoſe Years, the Accounts of the Small Pox and Meaſles are not diſtinguiſhed, as in the preceding and following Years, but are join'd together in one Article, ſo that from them no certain Account can be drawn of the Number of Perſons, that died of the Small Pox.

TABLE

TABLE I.

Years	Total No of Burials	Died of the Small Pox. In all.	In 1000	In Proportion.
1667	15842	1196	75	1/13
1668	17278	1987	115	1/9
1669	19432	951	49	1/20
1670	20198	1465	73	1/14
1671	15729	696	44	1/23
1672	18230	1116	61	1/16
1673	17504	853	49	1/21
1674	21201	2507	118	1/8
1675	17244	997	58	1/17
1676	18732	359	19	1/52
1677	19067	1678	88	1/11
1678	20678	1798	87	1/12
1679	21730	1967	91	1/11
1680	21053	689	33	1/31
1681	23971	2982	125	1/8
1682	20691	1408	68	1/15
1683	20587	2096	102	1/10
1684	23202	156	7	1/149
1685	23222	2496	107	1/9
1686	22609	1062	47	1/21
20 Years	398200	28459	71 1/2	1/14
Each Year at a *Medium*	19910	1423	71 1/2	1/14

TABLE II.

Years	Total No of Burials	Died of the Small Pox. In all.	In 1000	In Proportion.
1701	20471	1095	53	1/19
1702	19481	311	16	1/63
1703	20720	898	43	1/23
1704	22684	1501	66	1/15
1705	22097	1095	50	1/20
1706	19847	721	36	1/28
1707	21600	1078	50	1/20
1708	21291	1687	79	1/13
1709	21800	1024	47	1/21
1710	24620	3138	127	1/8
1711	19833	915	46	1/22
1712	21198	1943	92	1/11
1713	21057	1614	77	1/13
1714	26569	2810	106	1/9
1715	22232	1057	48	1/21
1716	24436	2427	99	1/10
1717	23446	2211	94	1/11
1718	26523	1884	71	1/14
1719	28347	3229	114	1/9
1720	25454	1440	57	1/18
1721	26142	2375	91	1/11
1722	25750	2167	84	1/12
22 Years	505598	36620	72	1/14
Each Year at a *Medium.*	22982	1665	72	1/14
42 Years	903798	65079	72	1/14
Each Year in 42 at a *Medium.*	21519	1550	72	1/14

By theſe Tables it appears, that *upwards of ſeven* per Cent. *or ſomewhat more than a fourteenth part of Mankind, die of the Small Pox*; and conſequently the hazard of dying of that Diſtemper, to every individual born into the World, is at leaſt that of one in fourteen. And that this Hazard encreaſes after the Birth, as the Child advances in Age, will appear from what follows.

From this Eſtimate it is demonſtrable, that, in the Caſe of Perſons actually having the Small Pox, the Hazard that they run, one with another, of dying of that Diſtemper, is greater than that of one in fourteen; or, which is the ſame thing, *there muſt be fewer than thirteen, that recover, for one that dies of the Small Pox.* For ſince one fourteenth part of Mankind die of the Small Pox, and the other thirteen parts die of other Diſeaſes; if theſe thirteen have all had the Small Pox, and recover'd from it, before they fell ill of thoſe other Diſeaſes of which they died, then juſt thirteen will have recover'd from the Small Pox, for one that dies of that Diſtemper: but, as it is notorious, that great Numbers, eſpecially of young Children, die of other Diſeaſes, without ever having the Small Pox, it is plain, that fewer than thirteen muſt recover from this Diſtemper, for one that dies of it.

To determine exactly how many of theſe thirteen Parts of Mankind, die without having the Small Pox, is a very difficult Task: but it is eaſy to ſee, that a conſiderable Deduction is to be made from them.

In the firſt place, the two Articles of *Stilborn* and *Abortive Children*, which are put into the yearly Bills, as part of the Number of Burials, are unqueſtionably to be deducted.

With theſe two, Sir, you will not I believe, think it unreaſonable to join the following Heads, which, by the beſt Information I can procure, comprehend only very young Children, or at moſt not above one or two Years of Age. *Overlaid, Chryſoms and Infants, Convulſions, Horſeſhoehead, Headmoldſhot, Teeth, Water in the Head, Worms, Rickets, Livergrown, Chin-Cough, and Hooping-Cough,* which Articles in the Yearly Bills for 22 Years laſt paſt, amount at a Medium to 386 in each 1000, of the whole Number of Burials.

It is true indeed, that, in all Probability, ſome ſmall part of theſe muſt have gone thro' the Small Pox, and therefore ought not to be deducted out of the Account: but then, on the other hand, as it is certain, that of the remaining $\frac{614}{1000}$ of Mankind, that are above one or two Years of Age, there are great Numbers, that never have the Small Pox, it will I preſume be judged to be no unequal Suppoſition, if I ſuppoſe all that are contain'd under the Heads abovemention'd, to have miſs'd that Diſtemper, when by way of Compenſation, I allow all the remainder of Mankind to undergo it; which Conceſſion is ſo large, that it will abundantly make up for what I aſſume too much in the former Suppoſition.

Allowing therefore, that out of every 1000 Children that are born, 386 die under one or two Years of Age, without having the Small Pox, and 72 do ſome time or other die of that Diſtemper; it follows, that the Hazard of dying of it, to the remainder of Mankind, above one or two Years of Age, who are all ſuppoſed to undergo that Diſeaſe ſooner or later, is that of 72 out of 614, or nearly 2 out of 17: ſo that

no

no more, than between 7 and 8, can recover from that Diſtemper, for one that dies of it. And if any conſiderable part of the aforeſaid remainder of Mankind, more than is allow'd for above, do eſcape having the Small Pox, then the Proportion of thoſe that recover from it, will be ſtill ſmaller.

This Conſideration ſhews the Fallacy of one plauſible Argument, that has been often made uſe of on occaſion of the preſent Diſputes about Inoculation: Which is, that whatever be the Danger of dying of the Small Pox, to thoſe that actually have that Diſeaſe, yet, as great Numbers of Perſons never have the Small Pox at all, this Danger is what any particular Perſon may never be in; and therefore it will be Madneſs to undergo the hazard of Inoculation, be it great or ſmall, in order to prevent a Diſeaſe, which poſſibly may never befal one.

For if two parts in ſeventeen of all Mankind, that are above one or two Years of Age, muſt ſooner or later die of the Small Pox, it is plain, that how many parts ſoever of theſe ſeventeen are ſuppoſed to eſcape that Diſtemper, the Mortality among the remainder, who undergo it, muſt in proportion be ſo much the greater. As for inſtance, if 7 parts eſcape having the Small Pox, and 10 undergo it, then 2 out of 10, or 1 out of 5, that have the Small Pox, muſt die of that Diſeaſe.

And as it can never be known, whether or no any particular Perſon be one of thoſe, that are to have the Small Pox; his Hazard of dying of that Diſtemper, being made up of the Hazard of having it, and the Hazard of dying of it, if he has it, will be exactly the ſame, namely, that of 2 in 17, or 1 in 8 or 9, whether the proportion of Mankind, that eſcape having the Small Pox, be great or ſmall.

But as what has been ſaid concerning the Hazard of the natural Small Pox, is taken from an Account of 42 Years; whereas the Hazard of Inoculation is eſtimated only from what has happen'd in the ſpace of about 18 Months, ſince which time it had its firſt Riſe among us; it will perhaps be asked by ſome Perſons, why we do not likewiſe make the Eſtimate of the hazard of the natural Small Pox, from the laſt two Years alone, without running back into ſo great a number of Years, before Inoculation was begun?

To which we anſwer, that the Proportion of thoſe that die of the Small Pox, varies ſo much in different Years, as appears from the Tables above, that it was impoſſible to come at any Certainty in this point, from the conſideration of the two laſt Years alone: and if any one ſuſpects us of Partiality in proceeding after the manner we have done, he need only caſt his Eyes upon the ſecond Table, where he will find, that the Mortality of the natural Small Pox, for the two laſt Years, has conſiderably exceeded the Medium we have determin'd, from taking in two and fourty Years.

There is another Method, which, if it were put in practice in ſeveral large Towns, or Pariſhes, and for a ſufficient Number of Years, would enable us to come at a nearer and ſtill more certain Computation of the Proportion between thoſe that recover, and thoſe that die of the Small Pox: which is, to ſend a careful Perſon once a Year, from houſe to houſe, to enquire what Perſons have had the Small Pox, and how many have died of it, in the preceding Year. This has been done by Dr. *Nettleton* the laſt Year, at ſeveral Towns in *Yorkſhire*, &c. and the ſame was done at *Chicheſter* for the ſame Year, to the 15th of *October* laſt, by a Perſon of Credit, whoſe Account was communicated to me by my learned and ingenious Friend, Dr. *Whitaker*.

Such

Such another Account has been transmitted to me from *Haverford West*, in *South Wales*, by the Learned Dr. *Perrot Williams*, Physician in that Place. The Sum of these Accounts is as follows.

	Sick of the Small Pox.	Died.
Several Towns in *Yorkshire* — —	3405 —	636
Chichester — — — — —	994 —	168
Haverford West — — — —	227 —	52
Total	4626 —	856

From which it appears, that, upon a *Medium* between these Accounts, there *died of the Small Pox almost* 19 *per Cent.* or *nearly one in five*, of Persons of all Ages, that underwent that Distemper. Which is the more to be remarked, for that *out of* 82 *Persons*, that had the Small Pox by Inoculation, the same Year, and in the Neighbourhood of the same Places, *not one miscarry'd.*

Mr. *Mather* observes, in his Letter mention'd above, that *out of more than* 5000 *Persons that had the Small Pox* at *Boston* in *New England*, *within little more than half a Year*, *near* 900 *died*, which is more than one in six; and this Account added to those from *Yorkshire*, *Chichester*, and *Wales*, reduces the Proportion of those that die of the Small Pox to somewhat more than 18 *per Cent.* so that the Hazard of dying of that Distemper, to those who are taken ill of it, is that of *one in between five and six*, or something above *two in eleven.*

The Result therefore, Sir, of these Computations is, that, if the same Proportions should still continue, as have hitherto been determin'd by Observation, we must expect,

That of all the Children that are born, there will, ſome time or other, die of the Small Pox, *one in fourteen.*

That of Perſons of all Ages taken ill of the natural Small Pox, there will die of that Diſtemper, *one in five or ſix, or two in eleven.*

That of Perſons of all Ages inoculated, without regard to the Healthineſs or Unhealthineſs of the Subject, as was practiſed in *New England*, there will die *one in ſixty.*

That of Perſons inoculated with the ſame Caution in the choice of the Subjects, as has been uſed by the ſeveral Operators one with another, here in *England*, (if we allow in the two diſputed Caſes abovemention'd, that the Perſons died of the inoculated Small Pox) there will die *one in ninety one.*

But if thoſe two Perſons be allowed to have died of other Accidents or Diſeaſes, then we ſhall have reaſon to think, as far as any Judgement can be made from our own Experience here in *England*, that *none at all* will die of Inoculation, provided that proper Caution be uſed; as we are inform'd, on all hands, is the Caſe in *Turkey*: where *out of many thouſands*, that, in the ſpace of about fourty Years paſt, have been inoculated in and about *Conſtantinople*, by one *Greek* Woman, who ſtill continues that Practice, notwithſtanding her extreme old Age, *not ſo much as one Perſon has miſcarried*, as I am aſſured by the ingenious Dr. *le Duc*, a Native of *Conſtantinople*, who was himſelf inoculated there under the Care of his Father, an eminent Phyſician in that City.

I

I am, &c.

James Jurin.

POSTSCRIPT.

SINCE this Paper was drawn up and communicated to the Royal Society, the following Account of the Succeſs of Inoculation in and about *Boſton*, in *New England*, was procured at my Deſire, by my Ingenious Friend Dr. *Nesbitt*, from Capt. *John Osborne*, who reſided in that Town and Neighbourhood during the whole time of that Practice. I think proper to inſert it here, as it confirms the Extract given above from Mr. *Mather*'s Relation, and is a more particular Account of the Matter of Fact, than any that I have yet ſeen.

In *May*, 1721. the Small Pox was, by the Providence of God, brought into the Town of *Boſton*; in *June* it began to ſpread pretty much, and in the Month of *July* it was got into moſt parts of the Town, and a conſiderable Number of People died of it. At this time Inoculation was firſt put in practice by Dr. *Boyleſton*, who then perform'd it upon his own Child and a Negro-Servant, who both did well; notwithſtanding which, this Attempt gave great Uneaſineſs to the Neighbours. However the Practice went on, to the Number of about 40 Perſons, one of which was a Woman * of about 40 or 45 Years of Age, who got well over the Small Pox, as her Husband publickly declared, but had been before troubled with Hyſterick Fits, of which ſhe died ſome little time after. When about 70 Perſons had paſſed under the Operation, myſelf and Wife, who had hitherto been at a Place called *Roxbury*, a Mile from *Boſton*, went into

* *Mrs.* Dixwell.

Town

Town and received the Small Pox by Inoculation. We had it with all the Gentleneſs and Moderation that was poſſible, neither of us having an hundred Puſtules, or being ſenſible of any Fever worth mentioning; ſo that we did not find it neceſſary to keep our Beds for it.

In *Auguſt* the Small Pox in the natural Way proved more mortal, and Inoculation made a greater Progreſs, the People continuing to come into the Practice of it. A ſecond Perſon that died after Inoculation, was an Apothecary's Houſekeeper, that was out of Town, till an *Indian* Maid got the Diſtemper in the ſame Houſe, and remov'd, and died. Upon which this Woman coming to Town, her Maſter undertook to perform the Operation upon her, which by the Way was the firſt and laſt that he ever perform'd; and on the third Day after the Inoculation, the Small Pox came out upon her very full; from which it was plain, that ſhe had taken the Infection before, in the common way.

The third Perſon that died after being inoculated, was a † Gentleman, that lodged in the ſame Houſe with my Wife and ſelf at *Roxbury*, who was under great and extreme Infirmity of Body, as myſelf was Witneſs, that we fear'd he would have lived but a ſhort time under it. His Friends much perſuaded him to make uſe of Inoculation, believing that it would have carry'd off his Illneſs; but when he made the Experiment, he had not Strength to go thro' with it. He was about 45 Years of Age, and by the way was a Gentleman of great Worth and Piety.

His Siſter ‡ was the fourth Perſon that died upon this Operation. She was about fourty Years of Age,

† John White, *Eſq*; ‡ *Mrs.* Wells.

of

of great Indiſpoſition of Body, and weak, as was her Brother.

The fifth, that died upon Inoculation, was a Woman Servant in a Houſe, where the whole Family, to the number of eight, were inoculated at the ſame time. She lay in a cold upper Room during her Illneſs, and was much neglected, the whole Family being down together, ſo that ſhe died merely for want of a little Attendance. This was in the Town of *Roxbury*, where obſerve, that 13 Men, Maſters of Families, got the Small Pox, and all died; which inclined the People to make uſe of Inoculation, having before been much againſt it, and there were 43 Men inoculated there, who all did well. The * Miniſter of the Town was the firſt, that put it in Practice there, much againſt the Mind of his People at firſt, though afterwards they were very well pleas'd with it, ſeeing with what great Succeſs it was attended; and then whole Families came into it, and underwent the Operation. There were in all at leaſt 280 Perſons inoculated, that I knew of, and I ſuppoſe there might be about 20 or 30 more, but of thoſe I can give no certain Account.

John Osborne.

* *The Reverend Mr.* Walter.

VII. *De Sectione Anguli, Autore* A. de Moivre, R. S. S.

IN eunte Anno 1707, incidi in Methodum quâ, Æquatione datâ hujus formæ.

$$ny + \frac{nn-1}{2\times 3} Ay^3 + \frac{nn-9}{4\times 5} By^5 + \frac{nn-25}{6\times 7} Cy^7 \&c. = a,$$

Vel istius,

$$ny + \frac{1-nn}{2\times 3} Ay^3 + \frac{9-nn}{4\times 5} By^5 + \frac{25-nn}{6\times 7} Cy^7 \&c. = a;$$

ubi quantitates A, B, C, &c. repræsentant Coefficientes Terminorum præcedentium, Radices determinavi ad hunc modum.

Posito $a + \sqrt{aa+1} = v$ in primo casu.

$a + \sqrt{aa-1} = v$ in secundo.

Erit $y = \frac{1}{2}\sqrt[n]{v} - \frac{1}{2\sqrt[n]{v}}$ in primo casu.

$y = \frac{1}{2}\sqrt[n]{v} + \frac{1}{2\sqrt[n]{v}}$ in secundo.

Solutiones autem istæ insertæ fuerunt in Philosophicis Transactionibus, Num. 309, pro mensibus *Jan. Feb. Mart.* ejusdem anni.

Jam quibus perspectum erit quo artificio Formulæ istæ inventæ fuerint, his procul dubio patebit aditus ad demonstrationem sequentis Theorematis.

Sit

Sit x Sinus Verſus Arcus cujuſlibet.

t Sinus Verſus Arcus alterius.

1 Radius Circuli.

Sitque Arcus prior ad poſteriorum ut 1 ad n, Tunc, aſſumptis binis Æquationibus quas cognatas appellare licet,

$$1 - 2z^{n} + z^{2n} = -2z^{n}t$$
$$1 - 2z + zz = -2zx.$$

Expunctoque z, orietur Æquatio qua Relatio inter x & t determinatur.

COROLLARIUM I.

Si Arcus poſterior ſit Semicircumferentia, Æquationes erunt.

$$1 + z^{n} = 0$$
$$1 - 2z + zz = -2zx.$$

e quibus ſi expungatur z, orietur Æquatio quâ determinantur Sinus Verſi Arcuum qui ſint ad Semicircumferentiam, ſemel, ter, quinquies, &c. ſumptam, ut 1 ad n.

CORROLLARIUM II.

Si Arcus poſterior ſit Circumferentia, Æquationes erunt

$$1 - z^{n} = 0$$
$$1 - 2z + zz = -2zx.$$

e quibus ſi expungatur z, orietur Æquatio quâ determinantur Sinus Verſi Arcuum qui ſint ad Circumferentiam, ſemel, bis, ter, quater, &c. ſumptam, ut 1 ad n.

CORALLARIUM III.

Si Arcus poſterior ſit 60 Graduum, Æquationes erunt

$$1 - z^n + z^{2n} = 0$$
$$1 - 2z + zz = -2zx.$$

e quibus ſi expungatur z, orietur Æquatio quâ determinantur Sinus Verſi Arcuum qui ſint ad Arcum 60 Graduum.

per $\left\{\begin{matrix}1, & 7, & 13, & 19, & 25 \\ 5, & 11, & 17, & 23, & 29\end{matrix}\right.$ &c. $\}$ multiplicatum ut 1 ad n.

Si Arcus poſterior ſit 120 Graduum, Æquationes erunt

$$1 + z^n + z^{2n} = 0$$
$$1 - 2z + zz = -2zx.$$

e quibus ſi expungatur z, orietur Æquatio quâ determinantur Sinus Verſi Arcuum qui ſint ad Arcum 120 Graduum.

per $\left\{\begin{matrix}1, & 4, & 7. & 10, & 13 \\ 2, & 5, & 8, & 11, & 14\end{matrix}\right.$ &c. $\}$ multiplicatum ut 1 ad n.

Novemb. 15.
1722.

VIII. *An*

VIII. *An Account of a new ſort of* Moloſſes *made of Apples; and of the degenerating of Smelts.* By the *Honourable* Paul Dudley, *Eſq; F. R. S.*

THE Apple, that produces the *Moloſſes*, is a Summer-Sweeting, of a middling Size, pleaſant to the Taſte, and full of Juice, ſo that ſeven Buſhels will make a Barrel of Cyder. The manner of making it is thus; you grind and preſs the Apples, and then take the Juice and boil it in a Copper till three Quarters of it is waſted, which will be done in about ſix Hours gentle boiling; and by that Time it comes to be of the Sweetneſs and Conſiſtency of *Moloſſes*.

Some of our People ſcum the Cyder as it boils, others do not, and yet there ſeems to be no great difference in the Goodneſs.

This new *Moloſſes* anſwers all the Ends of that made of the ſweet Cane imported from beyond Sea. It ſerves not only for Food and brewing, but is of great Uſe alſo in preſerving of Cyder; two Quarts of it put into a Barrel of rack'd Cyder, will both preſerve and give it a very agreeable Colour.

The Apple *Moloſſes* was diſcovered a few Years ſince, by a * Gentleman of my Acquaintance, at *Woodſtock*, in this Province, a Town remote from the Sea, and where the *Weſt India Moloſſes* is dear and ſcarce; he ingenuouſly confeſſes the Diſcovery was purely accidental; but ever ſince he has ſupplied his Family with *Moloſſes* out of his Orchard, and his Neigbours alſo now do the like to their great Advantage.

* J. Chandler, *Eſq;*

Our

Our Country Farmers run much upon planting Orchards of theſe Sweetings, for fatting their Swine, and aſſure me it makes the beſt ſort of Pork. And I know the Cyder made of them to be better than that of other Fruit for Taſte, Colour, and keeping.

Two ſhort Miles from my Houſe we have a fine Pond, of half a Mile over, little or no Communication with the Sea. An ingenious man, ſome threeſcore Years ago, for an Experiment, took a Pail of large Smelts from the River and put them into this Pond, where they have increaſed abundantly, but are degenerated to a very ſmall ſort; for our River-Smelts I ſuppoſe are full as large as thoſe of the *Thames*, ſome of them I know, will weigh two Ounces and an half, whereas theſe ſmall ones will not weigh five Penny-Weight. We reckon the Pond-Smelt eats much better than the other, and then they are very tranſparent, and of a beautiful ſhining Pearl-Colour.

Roxbury, New England,
October 25, 1722.

Paul Dudley.

FINIS.

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IV. *Extracts of ſeveral Letters to the Publiſher, from the Reverend Dr.* Langwith, *Rector of* Petworth *in* Suſſex, *concerning the Appearance of ſeveral Arches of Colours contiguous to the inner Edge of the common Rainbow.*

V. *A Letter to Dr.* Jurin, *Coll. Med.* Lond. *Soc. & Secr. R. S. concerning the abovementioned Appearance in the Rainbow, with ſome other Reflections on the ſame Subject. By* Henry Pemberton, *M. D. R. S. S.*

VI. *Part of two Letters concerning a Method of procuring the Small Pox, uſed in* South Wales. *From* Perrot Williams, *M. D. Phyſician at* Haverford Weſt, *to Dr.* Samuel Brady, *Phyſician to the Garriſon at* Portſmouth.

VII. *Part of a Letter from the ſame Learned and Ingenious Gentleman, upon the ſame Subject, to Dr.* Jurin, *R. S. Secret.*

VIII. *A Letter on the ſame Subject, from Mr.* Richard Wright, *Surgeon at* Haverford Weſt, *to Mr.* Sylvanus Bevan, *Apothecary in* London.

IX. *An Account of ſome Experiments made to prove, that the Force of Moving Bodies is proportionable to their Velocities: (or rather that the* Momentum *of Moving Bodies is to be found by multiplying the Maſſes into the Velocities) In Anſwer to ſuch who have ſometime ago affirm'd, that that Force is proportionable to the Square of the Velocity, and to thoſe who ſtill defend the ſame Opinion. By the Reverend* John Theophilus Deſaguliers, *LL. D. F. R. S.*

I. *Obſervations*

I. *Obſervations on the Eclipſe of the Moon*, June 18, 1722. *and the Longitude of* Port Royal *in* Jamaica *determined thereby.* *By Dr.* Halley, *Aſtronomer Royal, F.R.S.*

THE Eclipſe of the Moon which happened in *June* laſt, 1722, was ſo far hid by the cloudy Sky, that neither myſelf, nor any of our Aſtronomical Friends, in or about *London*, could furniſh an Obſervation thereof worthy to be laid before the Society. But the ſame having been well obſerved at *Jamaica*, by the late curious Capt. *Candler*, Commander of his Majeſties Ship *Launceſton*, (whoſe Example it were to be wiſhed, others in the like Poſt would imitate) and at *Berlin*, by Mr. *Chriſtfried Kirck*, Aſtronomer of the Royal Academy of Sciences there. I thought it not amiſs to prefix to their Accounts that little I was able to note concerning it.

Sunday, *June* 18, *mane*, Having perfectly rectified my Clock ſo as to ſhew the Apparent Time, neither the tranſit of the Moon over the Meridian, nor the beginning of the Eclipſe which ſoon followed, could be ſeen thro' the very thick Cloud. At 13 *h.* 12′ *T. app.* a ſmall Particle of the Moons Body was ſeen through a very little *hiatus* in the Cloud, by which glimpſe I could only be aſſured that the Eclipſe was not yet Total. At 13 *h.* 29′ by ſuch another view. I was ſatisfied that it was now become Total; but in a Moment, it again diſappeared, till 14 *h.* 49′ 10″, when the Cloud beginning to break, I got time to meaſure with the Micrometer, the *Partes Lucidæ* now recovered in the Moon's Diameter, which I found 14′. 00″, though this not ſo well as I could wiſh, by reaſon of a thinner Sort of Cloud which perpetually intercurr'd, and render'd the Edge of the Shadow ſomewhat dubious.

At 15 *h.* 15′ the Moon was pretty well got out of the thick Cloud, but being very low, and the Daylight become ſtrong, ſhe ſhone very faintly, and the Shadow became worſe and worſe defined.

From

From 15 *h.* 26′ to 15 *h.* 27′ *T. app.* I doubted of the End, and am confident it did not exceed the 27th Minute. It ended overagainſt the North Part of the *Palus Mæotis* of Mr. *Hevelius*, much about the middle of the Weſtern or Right-hand Limb of the Moon, ſhe being then very near ſetting.

Capt. *Barth. Candler*, being then at *Port Royal*, in *Jamaica*, had much better Fortune, and a ſerene Sky from the Beginning to the End; who having uſed due care to be aſſured of his Times, by Altitudes taken with an Inſtrument of three Foot *Radius*, was pleaſed to ſend us the Reſult of his Obſervation as follows.

	h.	*′*	*″*
The Eclipſe began	6	59	10
Immerſion	8	7	50
Emerſion	9	11	0
The End	10	19	40
Whence the Middle	8	39	25

And ſuppoſing the Eclipſe to have ended at *Greenwich*, at 15 *h.* 26′ ½ the Difference of Longitude between *Port Royal* and *Greenwich*, will be 5 *h.* 6′ 50″, or 5 *h.* 6′ ½ from *London*, that is, 76 *gr.* 37′ ½.

Mr. *Kirck* being in a more Eaſterly Meridian, could ſee nothing of the Emerſion, but has carefully noted the Time of the Beginning and Immerſion, as he obſerved them at *Berlin*, *viz.* the Beginning of the Eclipſe at 12 *h.* 59′ 55″ and the Immerſion at 14 *h.* 8′ 8″. Now by comparing ſeveral Obſervations made at both Places, we have formerly concluded *Berlin* to be 54 Min. of Time, or 13½ *grad.* of Longitude more Eaſterly than *London*; wherefore at *London* it began at 12 *h.* 5′ 55″ and immerged at 13 *h.* 14′ 8″ that is, the beginning was later here than at *Jamaica* 5 *h.* 6′ 45″, and the Immerſion later 5 *h.* 6′ 18″, punctually agreeing with what reſulted from my own Obſervation of the End as aboveſaid; and ſufficiently with what I had long ſince determined from Obſervations ſent me from *Jamaica* by my old Aſtronomical Friend Mr. *Charles Boucher*.

II. *The*

II. *The Longitude of* Carthagena *in* America. *By the ſame.*

HAving lately, by the Favour of Sir *Hans Sloane*, received a Packet of Obſervations from *Cartagene* in *America*, made by Colonel *Don Juan de Herrera*, Chief Engineer of that City, I find among them one Immerſion of the firſt Satellite of *Jupiter* into his Shadow, obſerved there by a Teleſcope of 17 ½ Feet, on *April* 9. *Stilo vet.* 1722. at 15 *h.* 58 ′ 44 ″ apparent Time; and two Emerſions of the ſame, *viz. July* 5. 11 *h.* 23 ′ 41 ″ and *July* 21. 9 *h.* 42 ′ 17 ″ *Stil. vet.* all which tally with Obſervations made at *Wanſted*, by the Reverend Dr. *Pound* and Mr. *Bradley*, who obſerved there the very next Eclipſes to all the three; that is to ſay, the Immerſion by a fifteen Foot Tube, on *April* 11. 15 *h.* 28 ′ 40 ″ *Temp. æqu.* or 15 *h.* 30 ′ 25 ″ *Temp. app.* And the firſt Emerſion, *July* 7. 10 *h.* 59 ′ 28 ″ *Temp. æq.* by the Reflecter, and 18 ″ after, or 10 *h.* 59 ′ 46 ″ by the 15 foot Glaſs, that is, 10 *h.* 54 ′ 12 ″ apparent Time. The other was obſerved at *Wanſted. July* 23. 9 *h.* 19 ′ 10 ″ *Temp. æq.* both by the Reflecter and 15 foot Glaſs; that is to ſay, at 9 *h.* 13 ′ 35 ″ apparent Time. Subſtract from each of theſe one Period of this Satellite, or 1 *d.* 18 *h.* 28 ′ 36 ″ and *April* 9. 15 *h.* 58 ′ 44 ″ at *Cartagene* will be 21 *h.* 1 ′ 49 ″ of the ſame Day at *Wanſted*, and the difference of Meridians 5 *h.* 3 ′ 5 ″. Likewiſe by the firſt Emerſion, *July* 5. 11 *h.* 23 ′ 41 ″ at *Cartagene* was at *Wanſted* 16 *h.* 25 ′ 36 ″ of that Day, whence the Difference of Meridians 5 *h.* 1 ′ 55 ″. But by the laſt E-

 merſion,

mersion, *July* 21. 9*h*. 42′ 17″ at *Cartagene* was 14*h*. 44′ 59″ at *Wansted*; whence *Wansted* is 5*h*. 2′ 42″ more easterly than *Cartagene*: and taking the *Medium* of all three, 5*h*. 2′ 34″ or 75° 38′ may be taken for the true difference of Longitude, that is, 75 ½ from *London*, which compared with Capt. *Candler*'s Observation of the late Lunar Eclipse, shews *Cartagene* to be about 20 Leagues to the Eastwards of *Port Royal* in *Jamaica*.

III. *Cometæ* Berolini, *anno* 1718. *visi Observationes a* 18 Januarii, *Stylo novo, ad* 5 Febr. *ex Epistolâ Viri Cl.* Christfridi Kirchij, *Reg. Soc. Scient.* Berolin. *Astron. ad* Edm. Hallejum, *LL.D. R. S. S. desumptæ.*

MOnere hic debeo observationes Cometæ à me inventi, in *Novis Literariis Lipsienſ.* non esse accuratas; primo quidem, cum eas tantum amico cuidam festinanter transmiserim, ut etiam ille Cometam quæreret; deinde, cum etiam vitium typographicum irrepserit; nam die 23 Januarii mane, Cometa cum θ & φ Cassiopeæ (non vero δ & φ) constituebat triangulum æquicrurum; & vesperi φ Persei, Cometa & θ Cassiopeæ ad sensum erant in linea recta. Pleniorem Cometæ historiam jam paratam habeo, ex qua hæc breviter attingam. Observavi eum a die 18 *Jan.* ad 5 *Februarii.* Loca ejus ex observationibus ad horam 10 vespertinam cujusque diei, quo Cometa observari potuit, reducta, hæc Tabella exhibet.

Via

	Longitudo.			Latitudo.		
	o	′		o	′	
18 *Jan.*	27	26	♋	69	18	S.
21 *Jan.*	16	25 ½	♌	48	42	S.
23 *Jan.*	9	28 ½	♌	39	45	S.
26 *Jan.*	5	25 ½	♌	32	55	S.
27 *Jan.*	4	41	♌	31	24	S.
28 *Jan.*	4	4	♍	30	13	S.
30 *Jan.*	3	4	♍	28	23 ½	S.
31 *Jan.*	2	43	♍	27	40	S.
1 *Febr.*	2	25	♍	27	1	S.
2 *Febr.*	2	10	♌	26	22	S.
5 *Febr.*	1	39	♌	24	53	S.

Via ejus tranſiit ſupra tergum Urſæ minoris, prope Polarem, per crura & genua Cephei, Caſſiopeæ & Andromedæ. Nodus ejus deſcendens fuit in 21 ½ gradu Arietis, cum aliqua mutatione: Angulus orbitæ cometicæ & Eclipticæ 69 ½ grad. circiter, etiam cum aliqua variatione. Via Cometæ 2 fere gr. à Polo mundi tranſiit, & Æquatorem ſecavit in 20 ½ gr. à puncto æquinoctiali. Perigæum Cometæ fuit in 6° 6′ ♏. cum latitudine ſeptentrionali 62° 7′. Cometa in Perigæo fuit, ☉. 18 *Jan.* hor. 3. min. 9. mane. Motus Cometæ diurnus in orbita propria, in Perigæo (12 ſcilicet horis ante, & 12 poſt Perigæum) 22° 8′; ultimis vero diebus apparitionis 32′. Suppoſita Terra quieſcente, & Cometa in recta linea trajiciente, motus Cometæ fuit 391 partium, qualium diſtantia minima Cometæ à Terra 1000. De Parallaxi Cometæ nihil certi affirmare poſſum, niſi quod multum ſupra Lunam fuerit elevatus Cometa. Probabiliter vero conjicio, illum intra Planetarum orbes exſtitiſſe, imo in Perigæo multo propiorem nobis fuiſſe

Martis Sphærâ. Sit enim ſemidiameter orbitæ Terræ 10000 partium, erit ita motus diurnus Martis 139 vel 140. Si vero Cometam in orbita Martis exſtitiſſe ſuppono, cum latitudine 62° 7′ & motu diurno 22° 8′, ejus velocitas eſſet 2847 partium, ſi ſcilicet ſimul fuiſſet in oppoſitione Solis; cum autem differentia Longitudinis Solis & Cometæ in Perigæo tantum fuerit 141° 40′, motus diurnus Cometæ evadit 3200 part. & proportio motus Cometæ ad motum Martis ut 23 ad 1. Quare colligo Cometam intra ſphæram Martis exſtitiſſe. Si vero quis Cometam ad Saturni orbitam evehere vellet, deberet ipſi velocitatem tribuere, quæ eſſet ad velocitatem Saturni ut 600 ad 1; & quod uno die majus ſpatium percurriſſet, quam Terra dimidio anno abſolvere ſoleat. Ne dicam de diametro Cometæ, quæ non multo minor exiſtere debuiſſet tribus diametris Solis.

Comparationem inſtitui hujus Cometæ cum aliis, & invenio Cometam, quem *Regiomontanus* anno 1472 vel 1475. menſe *Jan.* & *Febr.* obſervavit, viam tenuiſſe non multo diverſam à via noſtri Cometæ; tranſiit enim per Urſam minorem & Cephei femora, per pectus vel collum Caſſiopeæ & cingulum Andromedæ; ac velocitas ejus maxima uno die fuit 40 grad. Anno 1556, alius Cometa eſt obſervatus, cujus Nodos *Camerarius* in 11° ♎ & ♈ ponit, & qui prope pedes Urſæ minoris, per Cepheum, ſupra Caſſiopeam, & per partes ſuperiores Andromedæ tranſiit, motu valde veloci in Perigæo. Quod ſi *Regiomontanus* Cometam anno 1475 obſervavit, (de quo tamen Aſtronomi valde dubitant) admirabilis eſſet convenientia inter hoſce tres Cometas: intervallum enim prioris à medio eſſet 81 annorum, & à medio Cometâ ad ultimum 162 ann. ut ita revolutio Cometæ poſſet eſſet 81 annorum; nec etiam Hiſtoria aliorum Cometarum hiſce male reſponderet.

IV. *Ex-*

IV. *Extracts of ſeveral Letters to the Publiſher, from the Reverend Dr.* Langwith, *Rector of* Petworth *in* Suſſex, *concerning the Appearance of ſeveral Arches of Colours contiguous to the inner Edge of the common Rainbow.*

WHEN the Primary Rainbow has been very vivid, I have obſerv'd in it, more than once, a ſecond Series of Colours within, contiguous to the firſt, but far weaker, and ſometimes a faint Appearance even of a third. Theſe increaſe the Rainbow to a Breadth much exceeding what has hitherto been determin'd by Calculation. I remember, I had once an Opportunity of making an ingenious Friend take notice of this Appearance, who was much ſurpriz'd at it, as thinking it not to be reconciled with the Theory.

Petworth, Jan. 12. 172$\frac{1}{1}$.

SInce my laſt I have obſerv'd ſomething of the ſame Nature, though not in the ſame Degree of Perfection, with what I ſent you an Account of before. On *Saturday* laſt, a little before ſix in the Evening, Wind at N. W. by W. we had here a lively, diſtinct, primary Rainbow, the inner and purple Colour of which had a far greater Mixture of red in it, than I could ever obſerve

ſerve in Sir *Iſaac Newton*'s oblong *Spectrum*. Under this was a ſpace, of a Breadth conſiderably leſs than that of the *Limbus* of the Rainbow, in which I could not diſtinguiſh any Colours: Still lower was a faint interrupted Arch of red, inclining to purple, which appear'd and vaniſh'd ſeveral times, while I was intent upon obſerving it.

My Suſpicion about this Phænomenon is, that the extraordinary Redneſs in the purple of the firſt Rainbow, is owing to the Mixture of the red Rays of a ſecond Series of Colours, with the purple Rays of the firſt; that the colourleſs Space conſiſted of Rays which are too weak to affect the Sight with diſtinct Colours; and that the innermoſt broken Arch was the ending of a ſecond and beginning of a third *Iris*.

P. S. I forgot to tell you, that as in the Account I ſend you here, I ſaw the purple of the ſecond *Iris* without the other Colours, ſo I have ſeen the other Colours, but not very diſtinct, without the purple: as alſo, that I could never ſee more than one Series of Colours near the Horizon.

Petworth, March 22.
172½.

YEſterday in the Evening, about a quarter before Six, Wind S. W. we had one of the fineſt Rain-that ever I beheld.

The firſt Series of Colours was as uſual, only the Purple had a far greater Mixture of red in it, than I have ever ſeen in the priſmatick Purple: Under this was a colour'd Arch, in which the green was ſo predominant,

dominant, that I could not diſtinguiſh either the yellow or the blue: Still lower was an Arch of purple, like the former, highly ſaturate with red, under which I cou'd not diſtinguiſh any more Colours.

I had the Pleaſure of viewing this delightful Object for a conſiderable time, without that vaniſhing and returning of Colours which I deſcrib'd in my laſt.

The Order of the Colours in this compounded Rainbow was, you ſee, red, yellow, green, blue, a Mixture of purple and red, green, (or rather a Mixture of yellow, green, and blue) a Mixture of purple and red.

I begin now to imagine, that the Rainbow ſeldom appears very lively without ſomething of this Nature, and that the ſuppos'd exact Agreement between the Colours of the Rainbow and thoſe of the Priſm, is the reaſon that it has been ſo little obſerv'd.

Petworth, March 27.
1722.

I Am afraid I ſhall tire you with the Hiſtory of this Phænomenon; but I have ſeen it in ſuch Perfection ſince the writing my laſt, that I cannot help being particular in my Account of it.

Auguſt the 21ſt, about half an hour paſt 5 in the Evening, Weather temperate, Wind at N.E. the Appearance was as follows; *viz.*

The Colours of the Primary Rainbow were as uſual, only the purple very much inclining to red, and well defin'd: Under this was an Arch of green, the upper part of which inclin'd to a bright yellow, the lower to a more duſky green: Under this were alternately two Arches of reddiſh purple and two of green: Under all a faint Appearance of another Arch of purple, which vaniſh'd

and

and return'd ſeveral times ſo quick, that we cou'd not ſteadily fix our Eyes upon it. Thus the Order of the Colours was

I. Red, Orange Colour, Yellow, Green, Light Blue, Deep Blue, Purple.

II. Light Green, Dark Green, Purple.

III. Green, Purple.

IV. Green, faint vaniſhing Purple.

You ſee we had here four Orders of Colours, and perhaps the beginning of a fifth, for I make no queſtion but that what I call the Purple, is a Mixture of the Purple of each of the upper Series with the Red of the next below it, and the Green a Mixture of the intermediate Colours. I ſend you not this Account barely upon the Credit of my own Eyes; for there was a Clergyman and four other Gentlemen in Company, whom I deſir'd to view the Colours attentively, who all agreed, that they appear'd in the manner that I have now deſcrib'd.

There are two things, which well deſerve to be taken notice of, as they may perhaps direct us in ſome meaſure to the Solution of this curious Phænomenon.

The 1ſt is,

That the Breadth of the firſt Series ſo far exceeded that of any of the reſt, that as near as I could judge, it was equal to them all taken together.

The 2d is,

That I have never obſerv'd theſe inner Orders of Colours in the lower Parts of the Rainbow, tho' they have often been incomparably more vivid than the upper

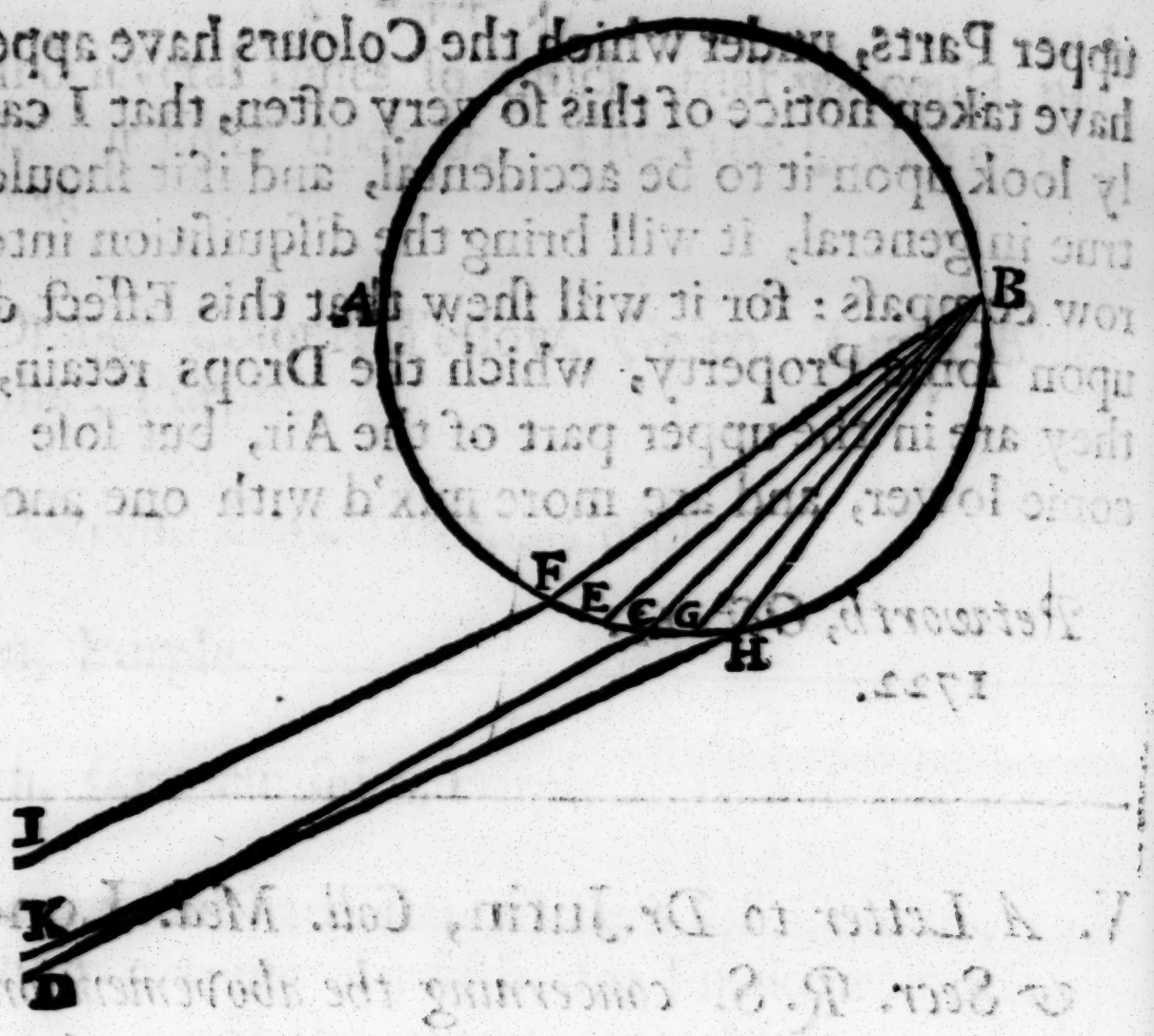
upper Parts, under which the Colours have appear'd. I have taken notice of this ſo very often, that I can hardly look upon it to be accidental, and if it ſhould prove true in general, it will bring the diſquiſition into a narrow compaſs; for it will ſhew that this Effect depends upon ſome Property, which the Drops retain, whilſt they are in the upper part of the Air, but loſe as they come lower, and are more mix'd with one another.

Petworth, Oct. 13. 1722.

V. *A Letter to Dr.* Jurin, *Coll. Med. Lond. Soc. & Secr. R. S. concerning the abovementioned Appearance in the Rainbow, with ſome other Reflections on the ſame Subject. By* Henry Pemberton, *M. D. R. S. S.*

SIR,

UPON your communicating to me the curious Obſervations, your Friend Dr. *Langwith* had made on the Rainbow, I inform'd you thoſe Appearances might, I thought, be explain'd by the Diſcoveries, the Great Sir *Iſaac Newton* had made in the Subject of Light and Colours, in his wonderful Treatiſe of *Optics*. As you ſeemed not diſpleaſed with what I mentioned to you in relation to this Matter by word of mouth, you deſired that I would ſet down in writing my Thoughts thereupon, which I have here accordingly done in the following manner.



Let AB repreſent a Drop of Rain, B the Point from whence the Rays of any determinate Species being reflected to C, and afterwards emerging in the Line CD, do proceed to the Eye, and cauſe the Appearance of that Colour in the Rainbow, which appertains to this Species. It is obſerved by Sir *Iſaac Newton* [a], that in the Reflection of Light, beſides what is reflected regularly, ſome ſmall part of it is irregularly ſcattered every way. So that from the Point B, beſides the Rays that are regularly reflected from B to C, ſome ſcattered Rays will return in other Lines, as in BE, BF, BG, BH, on each Side the Line BC. Further it muſt be noted from Sir *Iſaac Newton* [b], that the Rays of Light in their Paſſage from one Superficies of a refracting *Medium* to the other undergo alternate

[a] Optics, *Book* II. *Part* 4. [b] Ibid. *Part* III. *Prop.* xij.

Fits

Fits of eaſy Tranſmiſſion and Reflection, ſucceeding each other at equal Intervals; inſomuch that if they reach the further Superficies in one ſort of thoſe Fits, they ſhall be tranſmitted; if in the other kind of them, they ſhall rather be reflected back. Whence the Rays that proceed from B to C, and emerge in the Line C D, being in a Fit of eaſy Tranſmiſſion, the ſcattered Rays that fall at a ſmall Diſtance without theſe on either ſide, (ſuppoſe the Rays, that paſs in the Lines B E, B G) ſhall fall on the Surface in a Fit of eaſy Reflection, and ſhall not emerge; but the ſcattered Rays, that paſs at ſome Diſtance without theſe laſt, ſhall arrive at the Surface of the Drop in a fit of eaſy Tranſmiſſion, and break through that Surface. Suppoſe theſe Rays to paſs in the Lines B F, B H; the former of which Rays ſhall have had one Fit more of eaſy Tranſmiſſion, and the latter one Fit leſs, than the Rays that paſs from B to C. Now both theſe Rays, when they go out of the Drop, will proceed by the Refraction of the Water in the Lines F I, H K, that will be inclined almoſt equally to the Rays incident on the Drop, that come from the Sun, but the Angles of their Inclination will be leſs than the Angle, in which the Rays emerging in the Line C D are inclined to thoſe incident Rays. And after the ſame manner Rays ſcattered from the Point B, at a certain Diſtance without theſe, will emerge out of the Drop, while the intermediate Rays are intercepted; and theſe emergent Rays will be inclined to the Rays incident on the Drop in Angles ſtill leſs than the Angles, in which the Rays F I and H K are inclined to them; and without theſe Rays will emerge other Rays, that ſhall be inclined to the incident Rays in Angles yet leſs. Now by this means will be formed of every kind of Rays, beſides the principal Arch which goes to the Forma-

tion of the Rainbow, other Arches, within every one of the principal, of the ſame Colour, though much more faint: and this for divers Succeſſions, as long as theſe weak Lights, which in every Arch grow more and more obſcure, ſhall continue viſible. Now as the Arches produced by each Colour will be variouſly mixed together, the diverſity of Colours obſerved by Dr. *Langwith* may well ariſe from them.

The preciſe Diſtances between the principal Arch of each reſpective Colour and theſe fainter correſpondent Arches depend on the Magnitude of the Drops of Rain. In particular, the ſmalleſt Drops will make the ſecondary Arches of each Species at the greateſt Diſtance from their reſpective principal, and from each other. Whence, as the Drops of Rain increaſe in falling, theſe Arches near the Horizon by their great Nearneſs to their reſpective principal Arches become inviſible.

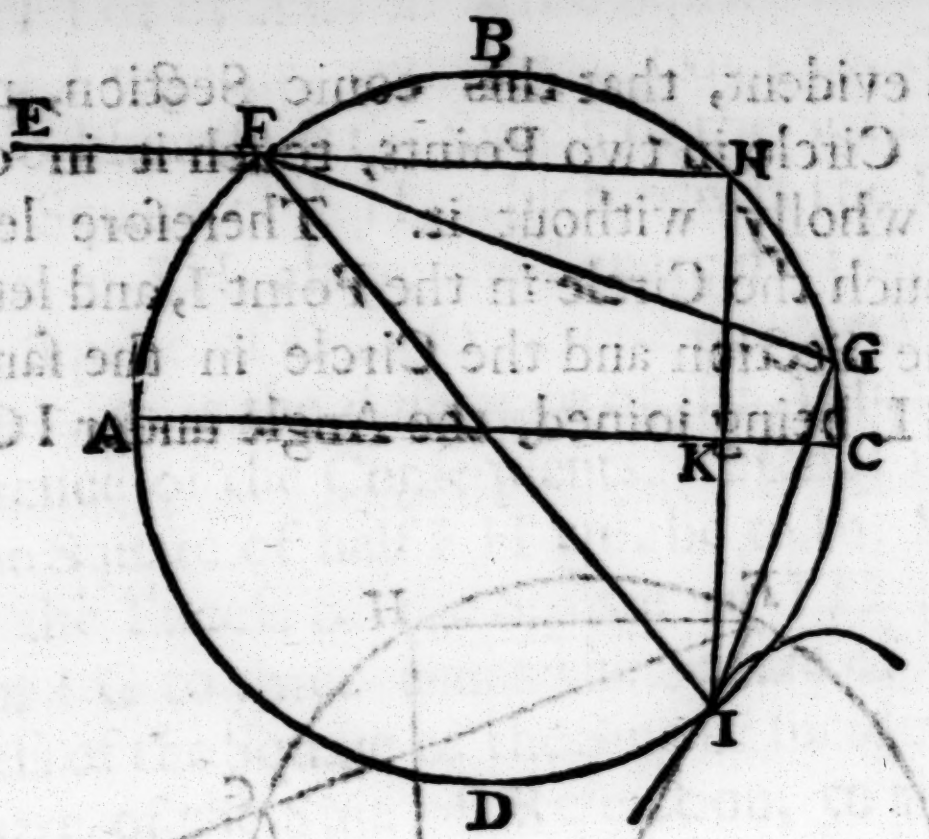
AND now, Sir, we are upon the Rainbow, I ſhall here take the Freedom of ſetting down two Propoſitions, which I have formerly conſidered, relating to this Subject. For the greater Brevity I ſhall deliver them under the Form of Poriſms; as, in my Opinion, the Ancients called all Propoſitions treated by Analyſis only.

PROPOSITION I.

In a given refracting Circle, whoſe refracting Power is given, the Ray is given in Poſition, which paſſing parallel to a given Diameter of the Circle is refracted by that Circle to a Point given in the Circumference of it.

Let

Let A B C D be the given Circle, the given Diameter A C, and given Point G; and let the Ray E F, parallel to A C, be refracted to G. I ſay E F is given in Poſition.



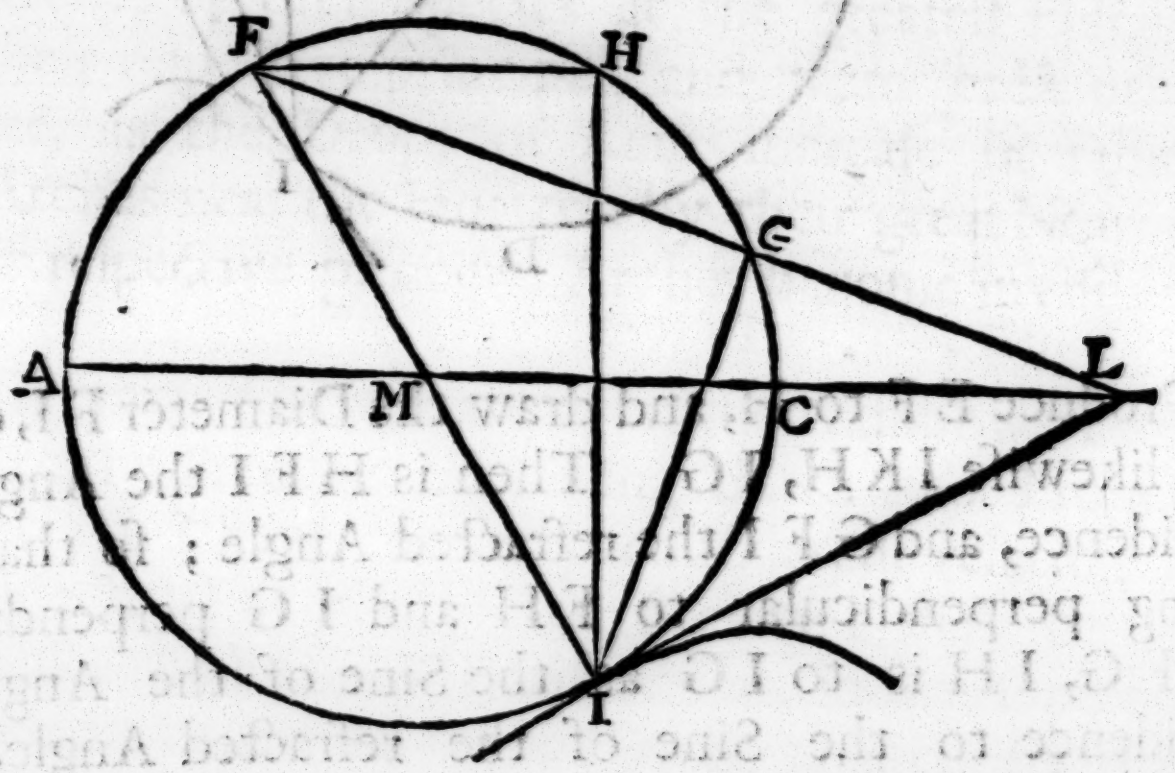
Produce E F to H, and draw the Diameter F I, drawing likewiſe I K H, I G. Then is H F I the Angle of Incidence, and G F I the refracted Angle; ſo that I H being perpendicular to F H and I G perpendicular to F G, I H is to I G as the Sine of the Angle of Incidence to the Sine of the refracted Angle, and the *Ratio* of I H to I G is given, as likewiſe the *Ratio* of I K to I G. Therefore I K being perpendicular to A C the Point I is in a Conic Section given in Poſition, whoſe Axis is perpendicular to A C, and one of its *Foci* is the Point G [a]. Conſequently the Points I and F are given, and laſtly the Ray E F given in Poſition.

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[a] *See* Papp. l. 7. prop. 238. Milnes Conic. part. 4. prop. 9.

DETERMINATION.

IT is evident, that this conic Section, may either cut the Circle in two Points, touch it in one Point, or fall wholly without it. Therefore let the Section touch the Circle in the Point I, and let I L touch both the Section and the Circle in the ſame point I. Then G L being joined, the Angle under I G L on ac-



count of the conic Section is a right one [a], ſo that F G L is one continued right Line, and I F is to I L as F G to G I; as likewiſe, M being the Center of the Circle, M I to I L, or F H to H I, as F G to twice G I, becauſe M I is to I F as G I to twice G I. Hence by Permutation F H is to F G as H I to twice G I; that is, as the Sine of the Angle of Incidence to twice the Sine of the refracted Angle.

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[a] De la Hire Conic. lib. 8. prop. 23.

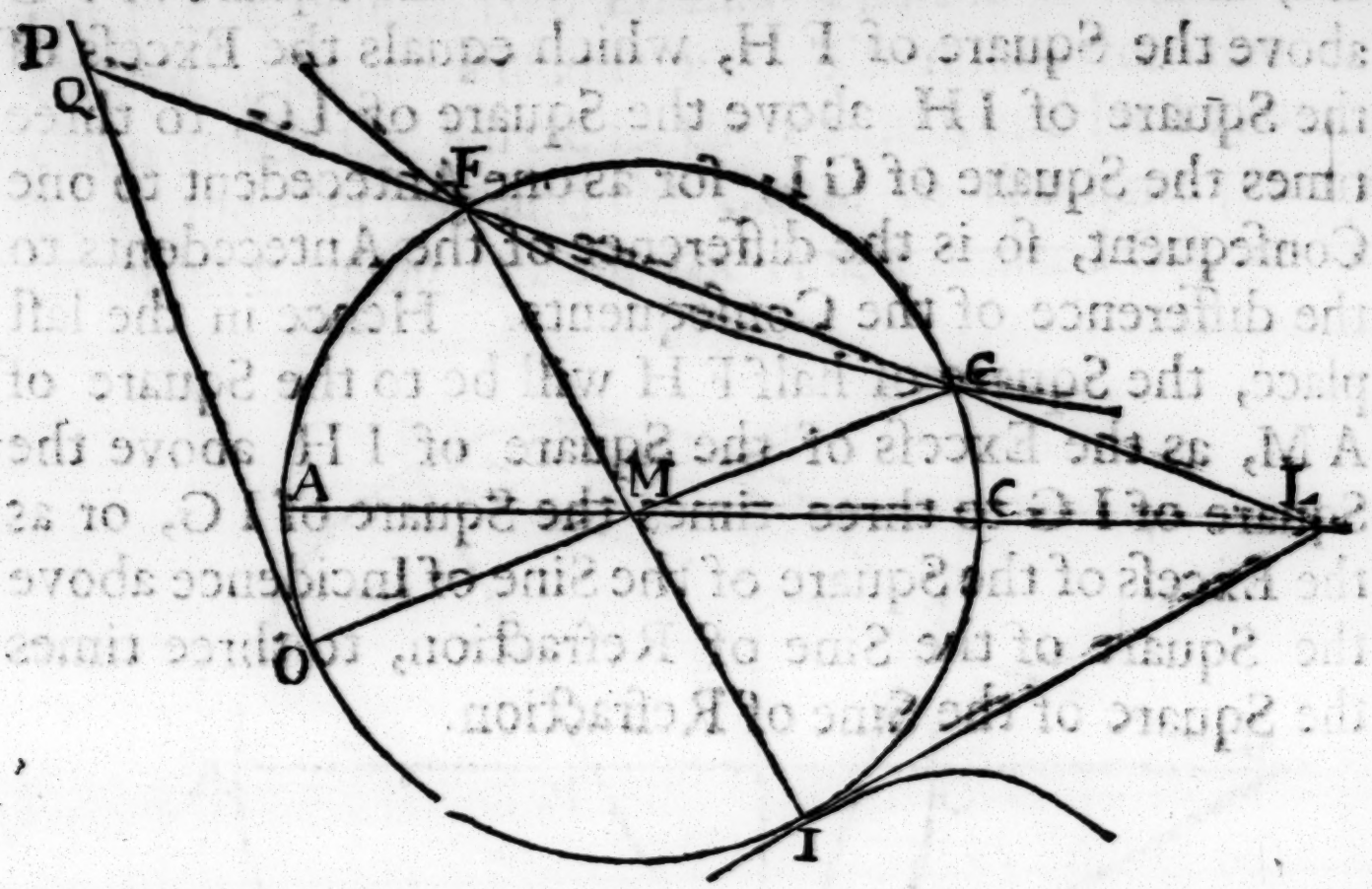
Moreover

Moreover F H being to H I as F G to twice G I, the Square of F H will be to the Square of H I, as the Square of F G to four times the Square of G I. Therefore, by Compoſition, as the Square of F H to the Square of F I or of A C, ſo is the Square of F G to the Square of F I together with three times the Square of G I, and ſo likewiſe is the Exceſs of the Square of F G above the Square of F H, which equals the Exceſs of the Square of I H above the Square of I G, to three times the Square of G I; for as one Antecedent to one Conſequent, ſo is the difference of the Antecedents to the difference of the Conſequents. Hence in the laſt place, the Square of half F H will be to the Square of A M, as the Exceſs of the Square of I H above the Square of I G to three times the Square of I G, or as the Exceſs of the Square of the Sine of Incidence above the Square of the Sine of Refraction, to three times the Square of the Sine of Refraction.

Another

Another DETERMINATION.

Draw the Diameter G O and the Tangent O P, meeting G F produced in Q: then the Angle under I F G is equal to the Angle under O G F, the Angle



under F I L equal to that under G O Q, both being right, and F I is equal to G O; whence the Triangles G O Q, F I L are ſimilar and equal; ſo that G Q is equal to F L, and the Point F in an *Hyperbola* paſſing through G, whoſe Aſymptotes are A C and O P [a].

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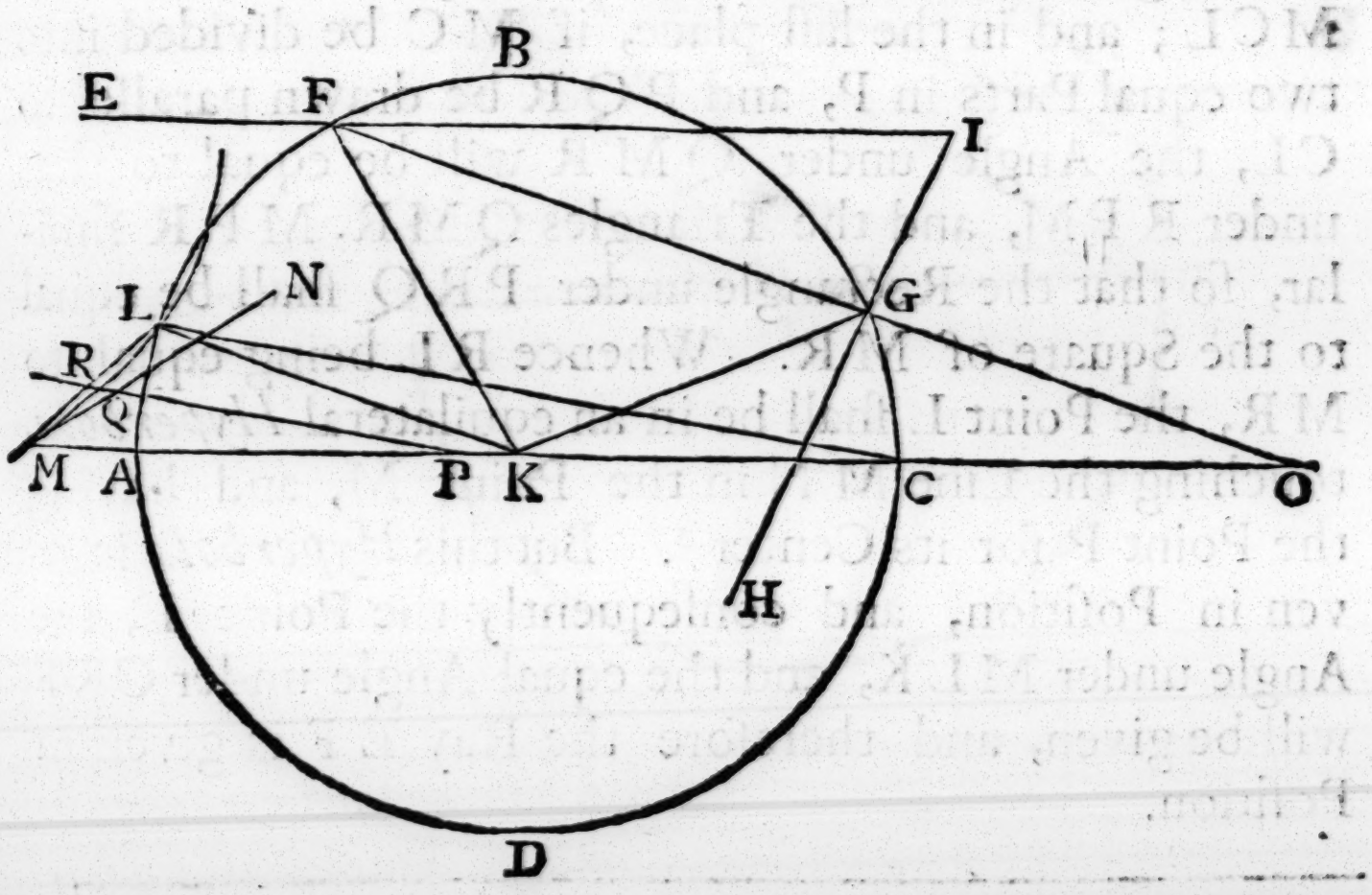
[a] Apoll. Conic. l. 2. prop. 8.

PROPO-

PROPOSITION II.

A refracting Circle and its refracting Power being given, the Ray is given in Position, which, paſſing parallel to a given Diameter of the Circle, after its Refraction, is ſo reflected from the farther Surface of the Circle, as to be inclined to its incident Courſe in a given Angle.

Let A B C D be the given Circle; let A C be the given Diameter, E F the incident Ray parallel to it, which being refracted into the Line F G ſhall ſo be reflected from the Point G in the Line G H, that E F and H G being produced, till they meet in I, the Angle under E I H ſhall be given.



Let K be the Center of the Circle, and K F, K G be joined; let the Semidiameter L K be parallel to the

 refracted

refracted Ray F G, and M K being taken to the Semidiameter of the Circle in the *Ratio* of the Sine of Incidence to the Sine of Refraction; let L M be joined, and laſtly make the Angle under K M N equal to half the given Angle under E I H. This being done, if F G be produced to O, F O ſhall be to K O as the Sine of the Angle of Incidence to the Sine of the refracted Angle, that is as M K to K L; in ſo much that K L being parallel to F O, and the Angle under M K L equal to that under F O K, the Angle under M L K ſhall be equal to that under F K O, and the Angle under K M L equal to that under K F O equal to that under F G K or half that under F G H, whence the Angle under K M N being equal to half the Angle under F I H, the reſiduary Angle under N M L will be equal to half the Angle under I F G or to half that under M K L. Therefore L C being drawn, the Angle under L M N will be equal to that under M C L; and in the laſt place, if M C be divided into two equal Parts in P, and P Q R be drawn parallel to C L, the Angle under Q M R will be equal to that under R P M, and the Triangles Q M R, M P R ſimilar, ſo that the Rectangle under P R Q ſhall be equal to the Square of M R. Whence R L being equal to M R, the Point L ſhall be in an equilateral *Hyperbola*, touching the Line M N in the Point M, and having the Point P for its Center [a]. But this *Hyperbola* is given in Poſition, and conſequently the Point L, the Angle under M L K, and the equal Angle under C K F will be given, and therefore the Ray E F is given in Poſition.

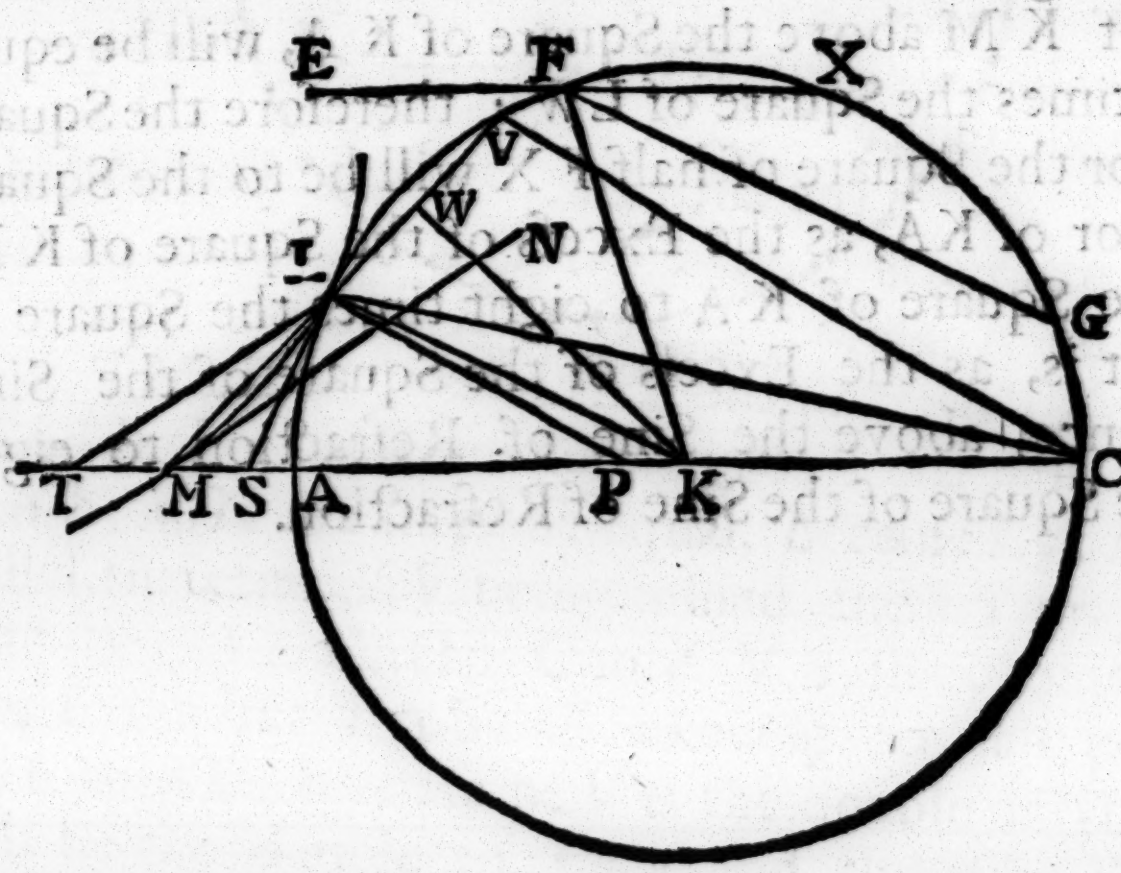
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[a] Apoll. Conic. lib. 1. prop. 37. *compared with* lib. 7. prop. 23.

D E-

DETERMINATION.

Let the *Hyperbola* touch the Circle in the Point L, and let their common Tangent be L S; draw L T parallel to M N, ſo as to be ordinately applied in the *Hyperbola* to the Diameter C M. Whence L S touching the *Hyperbola* in L, P T will be to T L as T L to T S [a], and the Angle under T S L equal to that under T L P, but as the Angle under S C L is equal to that under N M L, the ſame is equal to the Angle under T L M; therefore the Angle under S L C is equal to the Angle under M L P. Farther, M L being produced to V and V C joined, the Angle under L V C is



equal to that under S L C, by reaſon that L S touches the Circle in L; hence the Angles under L V C and under M L P are equal, L P, V C are parallel, and

[a] Apoll. Conic. lib. 1. prop. 37. *compared with* lib. 7. prop. 23.

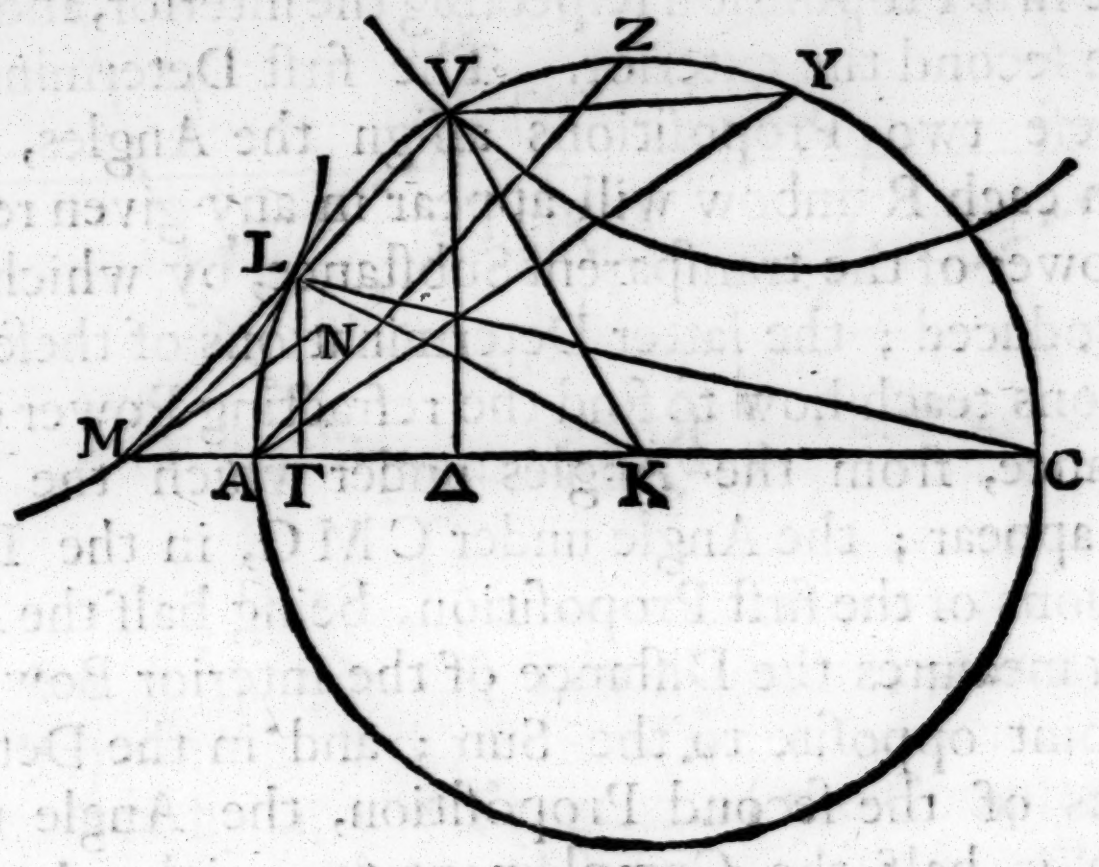
M P being equal to P C, M L is equal to L V; and K W being let fall perpendicular to L V, M W is equal to three times L W. But now if the incident Ray E F be produced to X, the Angle under M L K being equal to that under C K F, or to that under E F K, F X ſhall be equal to L V; equal to twice L W; and the Angle under K M L being equal to that under K F G; ſince K W is perpendicular to M W, F G ſhall be to twice M W as M K to K F, or as the Sine of Incidence to the Sine of Refraction: whence M W being equal to three times L W, F X ſhall be to F G as the Sine of Incidence to three times the Sine of Refraction.

Moreover, M W being equal to three times L W, the Square of M W will be equal to nine times the Square of L W, and the Rectangle under V M L, or the Rectangle under C M A, that is, the Exceſs of the Square of K M above the Square of K A, will be equal to eight times the Square of L W; therefore the Square of L W or the Square of half F X will be to the Square of K L, or of K A, as the Exceſs of the Square of K M above the Square of K A to eight times the Square of K A, that is, as the Exceſs of the Square of the Sine of Incidence, above the Sine of Refraction to eight times the Square of the Sine of Refraction.

Another

Another DETERMINATION.

Draw A Y parallel to M N, and A Z parallel to M V: then is the Angle under Y A *Z*, equal to that under L M N, which is equal to that under L C A; whence the Arches A L, Y *Z* are equal; but the



Arches A L, V Z are likewiſe equal, becauſe L V, A Z are parallel, therefore Y V being joined, and L Γ drawn perpendicular to A C, the Chord V Y ſhall be the double of L Γ; but V Δ being likewiſe let fall perpendicular to A C, becauſe M V is the double of M L, V Δ ſhall be the double of L Γ; and therefore V Δ and V Y ſhall be equal; whence the point V ſhall be in a *Parabola*, whoſe *Focus* is the Point Y, its Axis perpendicular to A C, and the *Latus rectum*, belonging to that Axis, equal to twice the perpendicular let fall from Y upon A C [a]. But if K V be joined, the

[a] Vide de la Hire Sect. Conic. lib. 8. prop. 1, 3.

Angle

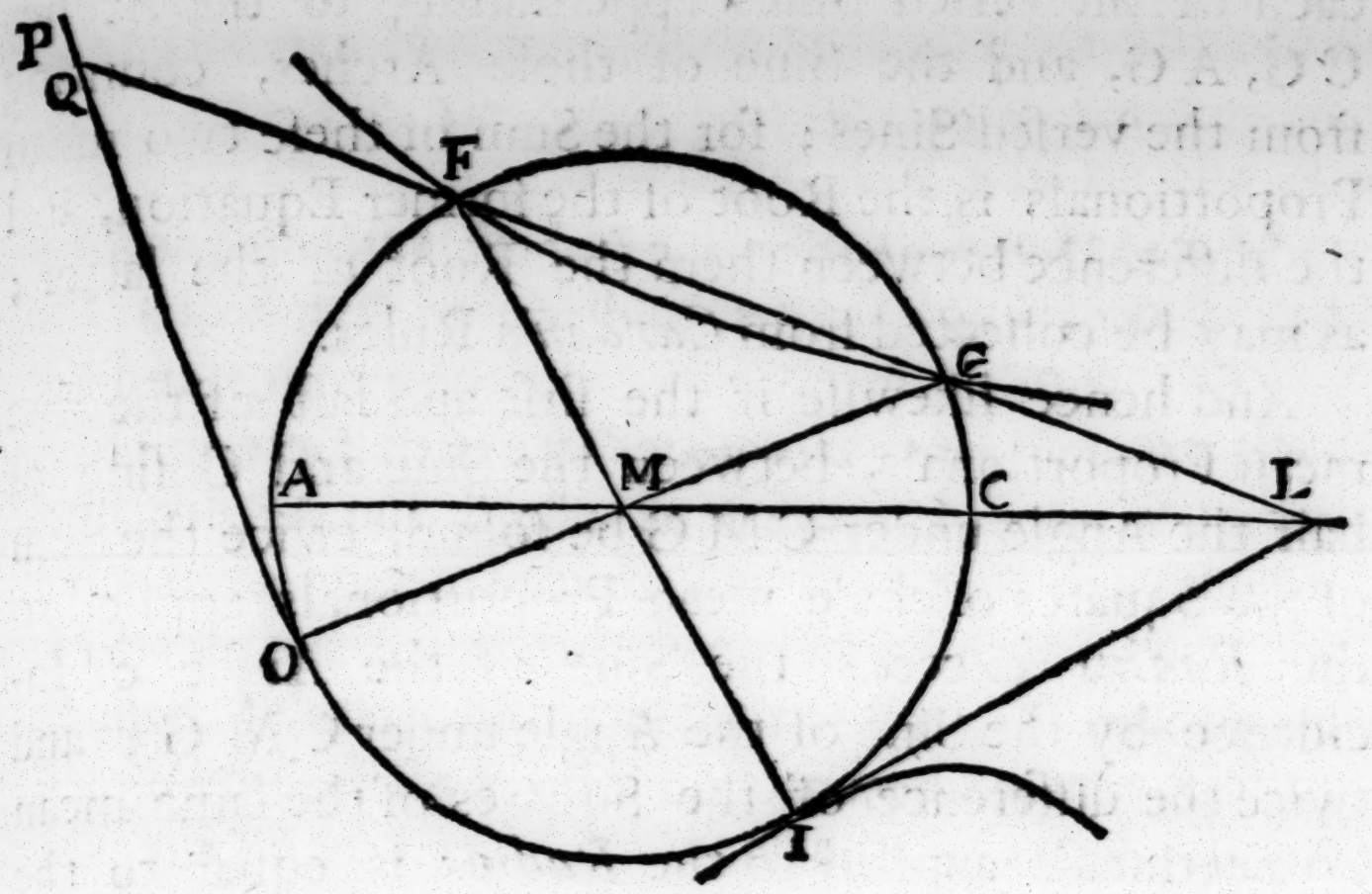
Angle under L K V is equal to twice the Complement to a right Angle of the Angle under K L V, which is equal to the Angle of Incidence, and exceeds the refracted Angle by the Angle under A K L.

THE Determinations of these two Propositions, have relation to the first and second Rainbow; those of the first Proposition respecting the interior, and those of the second the exterior. The first Determinations of these two Propositions assign the Angles, under which each Rainbow will appear in any given refracting Power of the transparent Substance, by which they are produced; the latter Determinations of these Propositions teach how to find the refracting Power of the Substance, from the Angles under which the Rainbows appear; the Angle under C M G, in the Determinations of the first Proposition, being half the Angle which measures the Distance of the interior Bow from the Point opposite to the Sun; and in the Determinations of the second Proposition, the Angle under C M N is half the Complement to a right Angle of half the Angle that measures the Distance of the exterior Bow, from the Point opposite to the Sun. But whereas these latter Determinations require solid Geometry, it may not be amiss here to shew how they may be reduced to Calculation, seeing the Observation of these Angles, as the learned Dr. *Halley* has already remark'd [a], affords no inconvenient Method of finding the refracting Power of any Fluid, or indeed of any transparent Substance, if it be formed into a spherical

[a] *Philosoph. Transact.* No. 267. *pag.* 722.

or

or cylindrical Figure. For this purpose therefore I

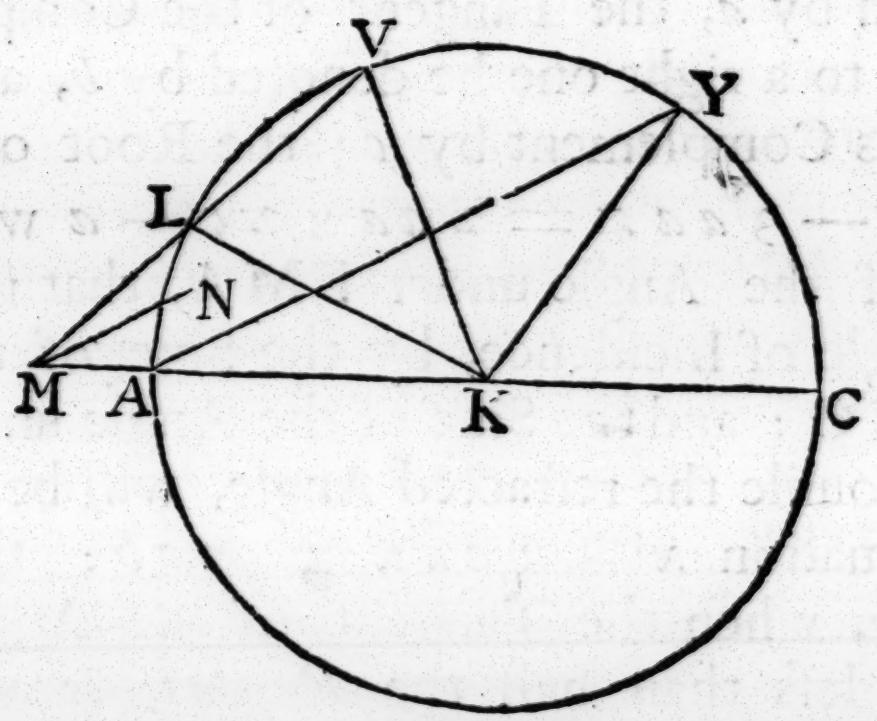


have found, that in the latter Determination of the first Propoſition, if the Sine of the Angle under CMG be denoted by *a*, the Tangent of the Complement of this Angle to a right one be denoted by *b*, and the Secant of this Complement by *c*; the Root of this Equation $z^3 - 3aaz = 2aa \times 2c - a$ will exceed the Sine of the Angle under FMA, that is the Sine of the Angle of Incidence, by the Sine of the Angle under CMG; and the Sine of the Angle under FMO, which is double the refracted Angle, will be the Root of this Equation $x^3 + 3aax = 4aab$; this Angle being acute, when the Tangent of the Angle under CMG is leſs than half the *Radius*, or when the Angle itſelf is leſs than 26 *degr.* 33′. 54″. 11‴, and when this Tangent is more than half the *Radius*, the Angle under OMF is obtuſe.

The

The Roots of these cubic Equations are found by seeking the first of two mean Proportionals, between each of the versed Sines appertaining to the Arches C G, A G, and the Sine of those Arches, counting from the versed Sines; for the Sum of these two mean Proportionals is the Root of the former Equation, and the difference between them the Root of the latter; as may be collected from *Cardan*'s Rules.

And hence likewise if the first and last of the five mean Proportionals, between the Sine and Cosine of half the Angle under C M G be found, twice the Sum of the Squares of these mean Proportionals applied to the *Radius* exceeds the Sine of the Angle of Incidence by the Sine of the Angle under C M G; and twice the difference of the Squares of the same mean Proportionals applied to the *Radius* is equal to the Sine of double the refracted Angle. Moreover this double of the refracted Angle exceeds the Angle of Incidence by the Angle under C M G.



In the latter Determination of the second Proposition draw K Y, and A Y being parallel to M N, the Angle under C K Y will be equal to twice the Angle under

under CMN, that is equal to the Complement of half the Distance of the exterior Rainbow from the Point opposite to the Sun. Then putting *a* for the *Radius* AK, and *b* for the Sine of the Angle under CKY, the Sine of the Angle under AKV will be the Root of this Equation $y^4 + 4by^3 - 8aaby + 4aabb = 0$. But the Angle of Incidence and Refraction may also be found as follows.

Let two mean Proportionals between the *Radius* and the Sine of the Angle under CKY be found, then take the Angle, whose Cosine is the first of these mean Proportionals, counting from the *Radius*; and also the Angle, whose Sine together with the second mean Proportional shall be to the *Radius* as the Cosine of the Angle under CKY to the Sine of the Angle before found. The Sum of these three Angles is double the Complement to a right one of the Angle under AKL, the Angle under KML, or the refracted Angle, being equal to half the Sum of this Angle under AKL and the Angle under CKY; as in the last Place the Angle under KLV, that is the Angle of Incidence, equal to the Sum of the Angles under KML and under MKL.

I need not observe, that the geometrical Methods of deducing these Angles of Incidence and Refraction from the Angle measuring the Distance of each Rainbow from the Point opposite to the Sun, afford very expeditious mechanical Constructions.

VI. *Part of two Letters concerning a Method of procuring the Small Pox, used in* South Wales.

From Perrot Williams, *M. D. Physician at* Haverford West, *to Dr.* Samuel Brady, *Physician to the Garrison at* Portsmouth.

HOwever new the Method of communicating the Small Pox may appear in this Kingdom; yet I am to acquaint you, that it has been commonly practised by the Inhabitants of this Part of *Wales* (*Pembrokeshire*) time out of mind; though by another Name, *viz.* that of buying the Disease, as I have been long ago acquainted by several, who procured the Distemper by that means. There is a married Woman in the Neighbourhood of this Place, who practised it on her Daughter, about a Year and a half ago, by which Means she had the Small Pox favourably, and is now in perfect Health, notwithstanding she has ever since, without Reserve, conversed with such as have had that Distemper this last Summer.

In order to procure the Distemper to themselves, they either rub the Matter taken from the Pustules when ripe, on several Parts of the Skin of the Arms, *&c.* or prick those Parts with Pins, or the like, first infected with the same Matter. And notwithstanding they omit the necessary Evacuations, such as Purging, *&c.* yet, as I am inform'd, they generally come off well enough; and what's remarkable, I cannot hear of one Instance of their having the Small Pox a second time.

A Learned and very Ingenious Gentleman of this Country told me not long since, that above twenty Years ago, when at School, he and several of his Schoolfellows, (how many I don't exactly remember) infected themselves at the same time, from the same Person, and that not one of them miscarry'd, though he had more of the Small Pox than he design'd. I am satisfy'd he will readily give a more particular Relation of this Affair, if desired. I am sorry he happens at present to be at a considerable Distance from this Town, otherwise I would have been more exact in this Account.

Haverford West,
Sept. 28. 1722.

Perrot Williams.

I Should not have so long omitted the Return of my Thanks, for the Favour of yours of *Oct.* 15. but that I hitherto waited an Opportunity to speak with the Gentleman, whom I mention'd in my last. His Name is *George Owen*, a Counsellor at Law, eldest Son to Dr. *Owen*, formerly Archdeacon in the Diocese of St. *David*'s. He solemnly declares, that having, when at School, as I formerly said, rubb'd the Skin off his Left Hand, where the Scar is now very visible, with the back Edge of his Penknife, till the Blood began to appear, he apply'd the variolous Mat-

ter to that part; which by Degrees growing inflam'd, about a Week afterwards he fell into the Small Pox; and that he has ſince frequently converſed with ſuch as were ſick of that Diſtemper. He ſays alſo five or ſix more at leaſt of his Schoolfellows made the like Experiment on themſelves, at the ſame time, with the like Succeſs.

I have ſince talk'd with ſeveral more, who made the like Experiments on themſelves, ſome twenty, ſome ſixteen, &c. Years ago: who all poſitively affirm, they never had the Small Pox a ſecond time.

Haverford Weſt,
Nov. 23. 1722.

Perrot Williams.

VII. *Part of a Letter from the ſame Learned and Ingenious Gentleman, upon the ſame Subject, to Dr.* Jurin, *R. S. Secret.*

THE Buſineſs of my Profeſſion obliging me to go into the Country, as ſoon as I had the Favour of yours of *Jan.* 22. prevented my returning an Anſwer ſooner to the Queries you are pleas'd to propoſe.

I have little to add to what I have already mention'd to Dr. *Brady*, concerning the manner of communicating the Small Pox, more than that Mr. *Owen* was about fifteen Years of Age, when he made the Experiment on himſelf, and that he queſtionleſs had the genuine Small Pox; the Signs of 'em on his Face,

and the Mark on his Hand, where he apply'd the Matter, being ſtill ſo very viſible, as to put that matter beyond Diſpute. The Phyſician, who then attended him, is dead. Tho' I can't pretend to remember how many inform'd me of their procuring the Diſtemper in this manner; yet I can aver, that within the compaſs of twenty Years laſt paſt, I have been ſo often aſſured of the Truth of it, not by Children, but grown Perſons of undoubted Credit, that I am entirely ſatisfied it has been an immemorial Cuſtom in theſe Parts; and not only practiſed by Boys when at School, but alſo by many others of both Sexes more advanced in Years, and conſequently capable of diſtinguiſhing the Small Pox from other Diſtempers. There are now living, in this Town and Neighbourhood, five or ſix Perſons, who undoubtedly had that Diſtemper after taking the foreſaid Method to infect themſelves; one of whom, a young Woman aged 23, told me (ſince I received your Letter) that, about 8 or 9 Years ago, in order to infect herſelf, ſhe held twenty pocky Scabs (taken from one towards the latter end of the Diſtemper) in the Hollow of her Hand, a conſiderable time; that about ten or twelve Days afterwards ſhe ſicken'd, and had upwards of thirty large Puſtules in her Face, and other Parts; and that ſhe has ſince freely converſed with ſuch as have had the Small Pox on them.

To make it appear that Inoculation is a ſufficient Preſervative againſt receiving the Small Pox a ſecond time; about ſix Weeks ago, I cauſed my two Boys, who had been inoculated this laſt Summer, not only to ſee, but even to handle a Child, dying of a moſt malignant ſort of Small Pox; who notwithſtanding, I thank God, continue in perfect Health.

Upon

Upon a very exact Inquiry I find, that out of 227, who have had the Small Pox in the natural way, in this Town and a neighbouring Pariſh, ſince the Beginning of *June* laſt, 52 have died.

Haverford Weſt,
Feb. 2. 172½.

Perrot Williams.

POSTSCRIPT.

Juſt as I was concluding my Letter, being ſent for by a Gentleman about ſix Miles off, (where I ſaw two very melancholy Inſtances of the Severity of the confluent Small Pox) he took an occaſion to inform me, that a near Neighbour of his caus'd his Son, about ten Years of Age, near three Weeks ago, to buy (as he term'd it) the Small Pox, after the manner I deſcribed in my firſt Letter to Dr. *Brady*. Carefully viewing the Boy, I found him recovering from the diſtinct Kind of that Diſtemper, having not had, as I could perceive, above 40 pretty large Puſtules, which were then drying off. Had I not been ſcanted in Time, I queſtion not but I ſhould have been able to have given a great many Inſtances of the like Nature; but the hurry I have been continually in, ever ſince I receiv'd yours, muſt be my Apology, for that Deficiency, as well as the Uncorrectneſs of this Letter.

VIII. *A Letter on the ſame Subject, from Mr.* Richard Wright, *Surgeon at* Haverford Weſt, *to Mr.* Sylvanus Bevan, *Apothecary in* London.

I Received yours the 9th inſtant, and, in Anſwer to it, will readily give you all the Satisfaction I can, in relation to a very antient Cuſtom in this Country; commonly called *buying the Small Pox*, which, upon a ſtrict Inquiry, ſince I had your Letter, I find to be a common Practice, and of very long ſtanding; being aſſured by Perſons of unqueſtionable Veracity, and of advanced Age, that they have had the Small Pox communicated to themſelves this way, when about ſixteen or ſeventeen Years of Age, they then being very capable of diſtinguiſhing that Diſtemper from any other; and that they have parted with the Matter contain'd in the Puſtules to others, producing the ſame Effects. There are two large Villages in this County near the Harbour of *Milford*, more famous for this Cuſtom than any other, namely, *St. Iſhmael's* and *Marloes*. The old Inhabitants of thoſe Villages, (with which they abound, being in a healthful Situation) ſay, that it has been a common Practice with them time out of mind; and what was more remarkable, one *William Allen*, of *St. Iſhmael's*, ninety Years of Age, (who died about ſix Months ago or thereabouts.) declared to ſome Perſons of good Senſe and Integrity, that this Practice was uſed all his Time; that he very well remember'd his Mother's telling him, that it was a common Practice all her Time, and that ſhe got the Small Pox that way. Theſe, together with the many

other

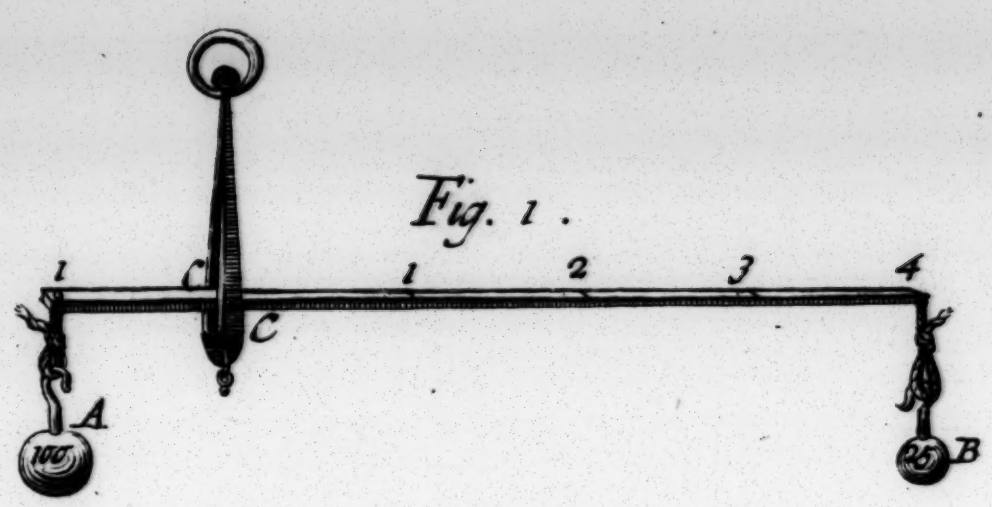
other Informations, I have met with from almoſt all parts of the County, confirm me in the Belief of its being a very antient and frequent Practice, among the common People; and to prove that this Method is ſtill continued among us, I will give you the relation of an elderly Woman, a Midwife, who accidentally came into Company, when your Letter was reading, whoſe Name is *Joan Jones*, aged ſeventy Years, of good Credit, and perfect Memory. She ſolemnly declares, that about fifty four Years ago, having then the Small Pox, one *Margaret Brown* (to the beſt of her Remembrance then about twelve or thirteen Years of Age) bought the Small Pox of her; that the ſaid *Margaret Brown* was ſeized with the Small Pox a few Days afterwards; that the ſaid *Margaret Brown* had not had the Small Pox a ſecond time, a twelve-Month ago, and ſhe verily believes, that ſhe has not had them ſince. She farther ſays, that ſhe has known this way of procuring the Small Pox practiſed from time to time, above fifty Years; that it has been lately uſed in her Neighbourhood, and that ſhe knows of but one dying of the ſaid Diſtemper, when communicated after the Method aforeſaid, which Accident happened within theſe two Years laſt paſt; the Perſon who miſcarried (a young Woman about twenty Years of Age) having procured the Diſtemper from a Man then dying of a very malignant Small Pox. The above Relation I heard the old Woman declare two Days ago, and ſhe was willing to take her Oath of it before Dr. *Williams*, who is a Magiſtrate. As to what you mention concerning the manner of communicating the infectious Matter to the Blood, by ſcraping the Skin thin with a Penknife, and ſo rubbing in the Matter, that was only the Caſe of one particular Gentleman, Mr. *Owen*, a Counſellor at Law, whom I heard ſeveral times poſi-

tively

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Fig. 1.



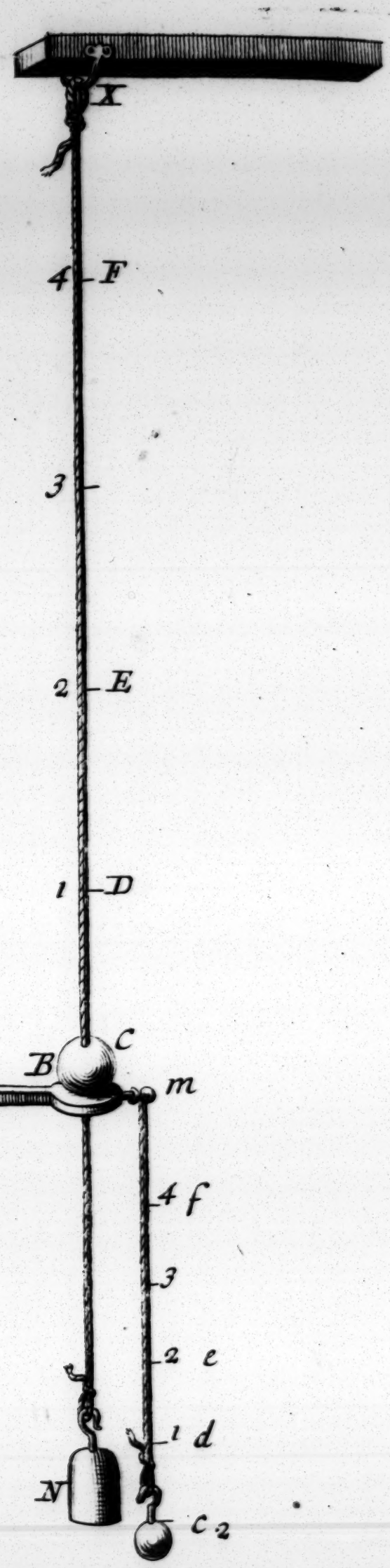
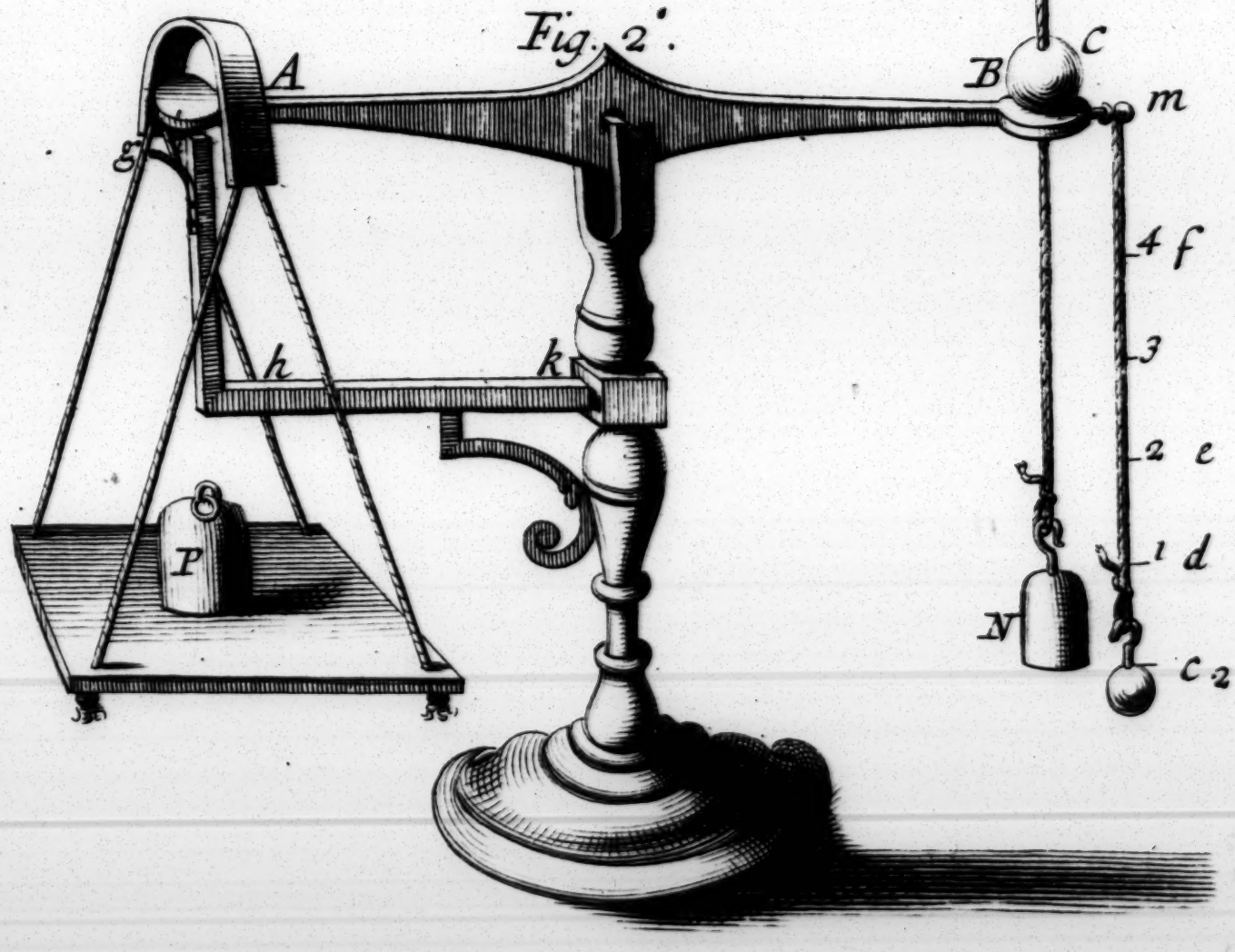


Fig. 2.



tively affirm, that he bought the Small Pox when at School, and of ſuch a Lady, now living, and gave her three Pence for the Matter contained in 12 Puſtules. That hundreds in this Country have had the Small Pox this way is certain; and it cannot produce one ſingle Inſtance of their ever having them a ſecond time.

Haverford Weſt,
Feb. 15. 172$\frac{2}{3}$.

Richard Wright.

IX. *An Account of ſome Experiments made to prove, that the Force of Moving Bodies is proportionable to their Velocities:* (*or rather that the* Momentum *of Moving Bodies is to be found by multiplying the Maſſes into the Velocities*) *In Anſwer to ſuch who have ſometime ago affirm'd, that that Force is proportionable to the* Square *of the Velocity, and to thoſe who ſtill defend the ſame Opinion. By the Reverend* John Theophilus Deſaguliers, *LL.D. F.R.S.*

AS far as I can learn, Monſieur *Leibnitz* was the firſt that oppos'd the receiv'd Opinion, concerning the Quantity of the Force of moving Bodies; by ſaying, that it was to be eſtimated by multiplying the Maſs of the Bodies, not by their Velocity, but by the Square of it. But, inſtead of ſhewing any Paralogiſm, in the mathematical Demonſtrations, which

 are

are made uſe of to prove the Propoſition, or any Miſtakes in the Reaſonings from the Experiments made to confirm it, he uſes other *Mediums* to prove his Aſſertions [a]; and without any Regard to what others had ſaid on that Subject, brings new Arguments, which the Reverend and Learned Dr. *Clark* has fully anſwered in his fifth Letter to him. Meſſieurs *John Bernoulli*, *Wolfius*, *Hermannus*, and others, have follow'd and defended Monſieur *Leibnitz*'s Opinion, and in the ſame manner, ſo that what is an Anſwer to him, is ſo to them.

Polenus (Profeſſor at *Padua*) has acted after the ſame manner in the experimental Way, making ſome Experiments to defend Monſieur *Leibnitz*'s Opinion, without having ſhewn thoſe to be falſe. which are made uſe of to prove the contrary [b]; and now lately, an ingenious Profeſſor abroad (who was of the Opinion commonly receiv'd, and in his Writings had demonſtrated it in the uſual way [c], confirming it with the common Experiments made in that Caſe) happening to make ſome Experiments like thoſe of *Polenus*, has drawn Concluſions from them to ſhew the Force of moving Bodies to be proportionable to the Square of their Velocity; and being wholly come over to that Opinion, endeavours to deduce it from Phyſical Principles.

As there can hardly be ſaid any thing new, or better than has been ſaid, to ſhew the Force abovemention'd to be proportionable to the Maſs multiplied into the Velocity; I only repeat here the Subſtance of what others have ſaid, and make ſome old Experiments over again; but then I conſider ſome Circum-

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[a] Acta Erudit. ad ann. 1686. p. 162. [b] Polenus de Caſtellis, p. 56, 57, &c. [c] Graveſande Introductio, Vol. I. No. 132.

ſtances

ſtances, that perhaps have been overlook'd, and at laſt, by a new Experiment, endeavour to ſhew, what has led into an Error ſome of thoſe, who defend the new Opinion.

If a Man with a certain Force can move a Weight of fifty Pounds, through a Space of four Feet, in a determinate time; it is certain he muſt employ twice that Force to move one hundred Pounds Weight, through the ſame Space in the ſame time. But if he uſes but the ſame Force, he will move the one hundred Pounds Weight but two Feet in the ſame time. For as the one hundred Pounds Weight contains two fifty Pound Weights, if each of them has two Degrees of Velocity given to it, it will exactly require the ſame Force that would give one of them four Degrees of Velocity; hence it appears, that the Force is proportionable to the Maſs multiply'd into the Velocity.

EXPERIMENT I.

Fig. 1. Let the Balance A B, whoſe *Fulchrum*, or Center of Motion, is at C, be ſo divided, that the *Brachium* A C be but the fourth Part of the *Brachium* C B; it is known to all Mechanicians, that a Weight of one hundred Pounds at A, will keep in *Æquilibrio* a Weight of twenty five Pounds hanging at B, where it will have a Velocity four times greater than that of the Weight at A. For, not only when the Balance is horizontal, there will be an *Æquilibrium*, but when the Balance is put in Motion, it will return to an *Æquilibrium* in an horizontal Poſition; the equal and contrary Forces applied at each, deſtroying one another. Whereas, if the Forces were as the Maſs multiply'd into the Square of the Velocity, the twenty five Pound Weight ſhould have been ſuſpended at D, only

twice as far from C, as the Weight at A; and in general, let the make of the Engine be what it will, let the mechanical Powers be combined in any manner, when two heavy Bodies, by means of a Machine, act upon one another in different directions, if their Velocities are reciprocally as their Maſſes, they will deſtroy each others Forces and come to reſt.

As this is true in reſpect of mechanical Powers, ſo it is in reſpect to the Shock or Blow given by falling Bodies. An heavy Body, falling with an accelerated Motion, goes through a ſpace of one Foot in a quarter of a Second, and acquires a Velocity, which would carry it two Foot in the ſame Time with an uniform Motion; the ſame Body falls through a ſpace of four Foot in half a Second, and acquires a Velocity, that would with an uniform Motion carry it eight Foot in half a Second. Therefore, as the Time of the fall through a ſpace of four Foot is twice the Time of a fall through one Foot, the Velocity in the latter Caſe is double that of the firſt, and conſequently the Blow, that the Body will give, will be double.

EXPERIMENT II.

Fig. II. Let the Weight P of one Pound, be placed in the Scale ſuſpended at the end A, of the Ballance A B, which bears upon the *Gnomon*, or Iron Supporter, *k h i*. Then if the Weight C be let fall from D, or one Foot, it will by its Stroke on the end of the Beam B, raiſe up the oppoſite end A with the Weight P, ſo high, that the Spring *g h* will fly from the Button *i*, which kept it ſtreight and upright before the Shock. If the Weight P be of two Pounds, it cannot be raiſed by the fall of C from any height leſs than F or four Foot; whereas, if the force of the Shock was proportionable to the Space,

without any regard to the time, as Monſieur *Leibnitz* and his followers have affirmed, P ought to be raiſed, when C falls only from E, or two Foot, which never happens; or, if the Stroke was proportionable to the Mass multiplied into the ſquare of the Velocity, when C falls from F, then P might weigh four Pound, whereas the Experiment will never ſucceed under thoſe Circumſtances.

I know it is objected, that the Blow cannot be always direct, and that the String that goes through the hole in the falling Weight, to guide it in its Fall, cauſes a ſenſible Friction, and therefore that ſomething of the Force is thereby loſt. But we are to obſerve, that if that was all, there would be no need of raiſing up C in the ſecond Caſe quite up to F, inſtead of E, whereas in Fact, it muſt always be raiſed beyond F, to allow for the Friction, that hinders it from producing a double Effect in falling from F. For if the Experiment be repeated an hundred times, the Weight, P when of two Pounds, will never be raiſed by letting C fall from any place between E and F.

EXPERIMENT III.

If (in order to avoid Friction) inſtead of a Blow ſtruck upon the end B, by the falling Body, the ſaid Body C be faſtned to a pretty long String tied to the button *m*, as at *c*, and firſt lifted up one Foot, and then let fall; ſo that in falling one Foot, it may pull down B, and lift up A with the Weight P of one Pound; whenever P is two Pounds, C muſt fall from a height greater than *f* or four Foot, otherwiſe it will not raiſe the *Brachium* A, eſpecially if it be let fall between *e* and *f*.

EXPE-

EXPERIMENT IV.

I took the Weight C of ſeventeen Ounces Troy, which was a round ball of Lead with a hole through the middle of it, and having paſſed the String N-X through it, before it was faſtened to the Hook X, I placed the whole Machine in ſuch manner, that the String being ſtretched by the Weight N, went through the hole of the Weight C, and likewiſe through the hole of the *Brachium* B, upon which *C* lay, without touching the ſides of the hole either in the Weight or Ballance; then having put ſuch a Weight P in the oppoſite Scale, as C falling from the height of one Inch, was able to raiſe high enough, to let looſe the Spring *g h* from the Button *i*: I added to P another Weight equal to it, and then letting fall C along the String that guided it, from an heighth of two Inches, then of three, and then exactly of four, it would not raiſe the double Weight P to the former height, but falling from five Inches, or a little higher, it raiſed it up.

EXPERIMENT V.

Leaving every thing as it was before, I changed the Weight C for another leaden Ball of twice the Weight, which falling from one Inch, raiſed the double Weight P to the uſual height; then changing the Weight *P* in any Proportion, whatever height was requir'd for the heavieſt Ball C (or C 2) to fall from, in order to raiſe the Weight at P; more than four times the height was required for the firſt Ball C, to raiſe the ſame Weight ſo high. as to let looſe the Spring.

EXPE-

EXPERIMENT VI.

I tried the Experiment with the Weight C hanging at the String *m c* (as in Experiment III.) and a Fall from an height of five, or near five Inches, was required to raiſe double the Weight in the oppoſite Scale, that a fall from one Inch would raiſe; only here the heighth above four Inches was not ſo great as in the former Experiment, the Friction being ſomething leſs. Then I ſuſpended the great Ball C (or C 2) by the String *m c*, and when by falling one Inch it raiſed the Weight P, the little Weight C could not produce the ſame Effect, without falling from a greater height than four Inches.

It is here to be obſerved, that which way ſoever theſe Experiments are tried, the Objections riſing from the Friction do no way ſerve to confirm the new Opinion, becauſe they ſhew that (upon account of the Friction) the Heights muſt be ſomething more than in a duplicate Proportion of the Velocities, but never leſs, to give a Blow with the ſame Body in Proportion to the Velocity.

That the *Momentum* of Bodies is in Proportion to the Maſs multiplied into the Velocity, is alſo moſt evidently ſhewn from the Congreſs of elaſtic Bodies, as has been demonſtrated by Sir *Iſaac Newton* in his *Principia*, in the Corollaries to his Laws of Motion. I had often tried the Experiments there mentioned with Balls of Ivory and Balls of Glaſs, and ſome of them with two Balls of Steel, of two Ounces each, and found every thing anſwer, allowing for the want of perfect Elaſticity in the Bodies. But now upon this Occaſion, as the Objections to the receiv'd Opinion were renewed, I was willing to repeat the Experiments with the utmoſt Accuracy; and therefore, as Ivory Balls

are

are not equally denſe in all their Parts, and Glaſs Balls break after two or three ſtrokes; I cauſed Balls to be nicely turned of Steel, and made as hard (as the Workmen call it) that is, as elaſtick as poſſible, and the Weights of them were preciſely as follows: Two Balls of twelve Ounces Troy each, one of ſix Ounces, one of three, one of two, and one of Eight-penny-weight. Then making Pendulums of theſe Balls, and hanging them upon the Machine contrived by *Mariotte* for the Congreſs of Bodies, and lately improved by Dr. *Graveſande*[a], I meaſured 57 ¼ Inches between the Center of Suſpenſion and the Center of Gravity of the Balls, and then every Degree of the Circle they deſcribed in their Oſcillation was one Inch, and the Degrees being marked upon a line of Chords on a Braſs Ruler above the Balls, by their Strings ſucceſſively covering the croſs Lines of Diviſion, the Degrees that the Balls fell from, and thoſe to which they roſe, were very diſcernable to an Eye placed at a convenient Diſtance.

EXPERIMENT VII.

I took the two Balls 12, and removing each from the loweſt Point of their equal and reſpective Circles, up to 4 Inches, or 4 Degrees, I let them fall ſo that they met at bottom, and were both reflected again to 4, the Place from whence they fell.

EXPERIMENT VIII.

Every thing elſe being as before, inſtead of one of the Balls 12, I took the Ball 6, then letting 6 go from

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[a] Introd. No. 170. Vol. 1.

8 Degrees,

8 Degrees, and 12 from 4, after Reflection 12 was driven up again to 4, as before.

EXPERIMENT IX.

The Ball 3 falling from ſixteen Degrees met the Ball 12 that fell ſtill from 4, and after Reflection 12 went up again to 4.

EXPERIMENT X.

The Ball 2 falling from 6° and 12 from 1°, 12 was reflected to 1, and when 2 fell from 12 Degrees, and the Ball 12 from 2, the 12 was reflected to 2.

EXPERIMENT XI.

The Ball of eight Penny Weight (which weigh'd but $\frac{1}{30}$ of the Ball 12) falling from fifteen Inches or Degrees, rais'd up 12 (that fell from half a Degree) to the ſame Place again.

In all theſe Experiments the Error, or want of perfect Reflection, was greater in the little Balls than in the great ones, on account of their going thro' a greater *Arc* of a Circle, whereby they deviated more from a Cycloid than the great ones; as likewiſe on Account of the Reſiſtance of the Air, which muſt be greater becauſe of the little Balls going through a greater *Arc*, moving with more Velocity, being ſuſpended by a String as thick as that of the great ones, and having more Surface in Proportion to their Weight. But all the Errors do not bring the *Phænomena* any thing near what they ought to be, if the Force of the Bodies was as the Square of their Velocities multiply'd into their Maſſes, for then the Ball 12 would have been driven to Heights very different from what it roſe up to.

In the eighth Experiment, the Ball 12 ſhould have riſen to near five Inches and three quarters, for the Ball 6 falling with the Velocity, 8 muſt have had its Force $= 8 \times 8 \times 6 = 384$; and then, that the Ball 12 might have the ſame Force or Quantity of Motion, it muſt riſe near to 5,7 becauſe $5{,}7 \times 5{,}7 \times 12 = 389{,}88$.

In the ninth, 12 ſhould have riſen to 8; for the Ball 3 muſt have had its Force $= 16 \times 16 \times 3 = 768$, and if 12 receiv'd its whole Force it muſt have riſen to 8 becauſe $8 \times 8 \times 12 = 768$.

In the ſecond Part of the tenth Experiment, 12 ſhould have riſen to near 5, becauſe $12 \times 12 \times 2 = 288$, and $5 \times 5 \times 12$ is but 300.

In the eleventh, the Ball 12 (thirty times heavier than the little one) muſt have gone to $2\frac{3}{4}$ Inches, becauſe the *Momentum* of the little Ball being $= 15 \times 15 \times 1 = 225$, that of the Ball 12 muſt be $= 2{,}75 \times 2{,}75 \times 12 = 226$ &c.

It may be here alledg'd, that one ought to ſubtract the *Momentum*, with which the great Ball comes upon the little one; but that won't mend the Matter much, tho' indeed the Difference will be leſs. For,

In the eighth Experiment, if we ſubtract $4 \times 4 \times 12 = 192$ from 389,88 there will remain 197,88, and the Ball 12 will go but to 4; but then in Experiment 9, if we ſubtract the ſame N° 192 from 768, we ſhall have 576, which would carry 12 to near ſeven Degrees, becauſe $7 \times 7 \times 12 = 588$.

In the tenth Experiment, there is only 48 to be ſubtracted; and in the eleventh only 15; and therefore the Velocity of 12 will very much fall ſhort of what is agreeable to the new Opinion.

After the Experiments made, and what has been ſaid, till theſe Conſequences are overthrown, no notice ought to be taken of any Objections, or new Experiments.

ments. But to give the Objectors all poſſible Satisfaction, I ſhall, in another Paper, endeavour to ſhew the Fallacies of the Arguments, and ſolve the *Phænomena* of the Experiments made; ſhewing, both by Reaſon and Experiment, that the Facts ought to be as they are, in conſequence of the receiv'd Opinion and Laws of Reſiſtance.

FINIS.

ERRATUM.

PAG. 250. in the Note for, de la Hire, &c. *read* Milnes, ibid.

LONDON: *Printed for* W. *and* J. Innys, *Printers to the* Royal Society, *at the* Prince's Arms *the Weſt End of St.* Paul's Churchyard.

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Jos: Banks

Numb. 376.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *March* and *April*. 1723.

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I. *A Catalogue of fifty Plants lately preſented to the* Royal Society, *by the Company of* Apothecaries *of* London; *purſuant to the Direction of Sir* Hans Sloane, *Bart. Preſident of the* College of Phyſicians, *and Vice-Preſident of the* Royal Society.

THE Company of *Apothecaries* of *London*, having, in the Year 1673, eſtabliſhed a Phyſick-Garden, which they have ſince furniſh'd with a great Variety of Plants, for the Improvement of their Members in the Knowledge of Botany; Sir *Hans Sloane*, Bart. in order to encourage and promote an Undertaking ſo ſerviceable to the Publick, has generouſly granted to the Company the Inheritance of the ſaid Garden, being part of his Eſtate and Manor of *Chelſea*, on condition that it be for ever kept up and maintain'd by the Company as a Phyſick-Garden; and as an Evidence of its being ſo maintain'd, he has directed and obliged the Company, in Conſideration of the ſaid Grant, to preſent yearly for ever to the *Royal Society*, at one of their weekly Meetings, fifty Specimens of Plants, that have grown in the ſaid Garden the preceding Year, which are all to be ſpecifically diſtinct from each other, until the Number of 2000 Plants be completed.

Accordingly the Company did lately preſent to the *Royal Society*, by the Hands of Mr. *Rand*, and Mr. *Meres*, the following fifty Specimens of Plants, for the

laſt Year 1722. which Specimens, together with thoſe that are to follow them in ſubſequent Years, will, by order of the *Royal Society*, be carefully preſerv'd for the Satisfaction of ſuch curious Perſons, as may deſire to have recourſe to them.

The Catalogue, by Mr. *Iſaac Rand*, Apothecary, *F. R. S.*

I. A *Nemone Virginiana, tertiæ Matthioli ſimilis, flore parvo,* Par. Bat. 18.

II. *Bellis Africana, capitulo aphyllo luteo, Coronopi folio, caulibus procumbentibus.* H. L. Bat.

III. *Bupleurum angũſtifolium.* Dod. 633.

IV. *Calamintha, magno flore,* C. B. 229.

V. *Carduus capite rotundo tormentoſo.* C. B. 382.

VI. *Chryſanthemum perenne, minus, Salicis folio glabro.* H. Ox. p. 3. 21.

VII. *Cirſium altiſſimum, albis maculis notatum, ſemine viſcoſo. Carduus albis maculis notatus, capitulis Cirſij.* Schol. Bot. 215.

VIII. *Clematitis cœrulea erecta.* C. B. 300.

IX. *Clematitis, ſ. Flammula ſurrecta alba.* J. B. 2. 127.

X. *Cnicus*

X. *Cnicus perennis cœruleus, Tingitanus.* H. L. Bat. 162.

IX. *Conyza Africana, Senecionis flore, retusis foliis.* H. L. Bat.

XII. *Corona Solis altissima, alato caule.* T. Inst. 490.

XIII. *Coronilla maritima glauco folio.* T. Inst. 650.

XIV. *Cucubalus Plinij.* Lugd. 1429.

XV. *Daucus Fœniculi foliis tenuissimis.* C. B. 150.

XVI. *Daucus maritimus lucidus.* T. Inst. 307.

XVII. *Dens Leonis, foliis Erysimi vulgaris.* T. Cor. 35.

XVIII. *Geranium columbinum dissectis foliis, pediculis florum longissimis.* Raij Syn. 218.

XIX. *Geranium columbinum perenne Pyrenaicum maximum.* T. Inst. 268.

XX. *Geranium pusillum maritimum supinum, Althææ aut Betonicæ folio, nostras.* Raij Syn. 216.

XXI. *Gnaphalodes Lusitanica.* T. Inst. 439.

XXII. *Horminum Sylvestre latifolium, verticillatum.* C. B. 238.

XXIII. *Hypericum perfoliatum & perforatum.* T. Inst. 255.

XXIV.

XXIV. *Jacea altissima, folio dissecto, capite Ovarii nudo.* D. Vaillant.

XXV. *Jacea Lusitanica, semper virens.* H. Reg. Par.

XXVI. *Jacobæa perennis Asplenii folio.* D. Vaillant.

XXVII. *Lotus pentaphyllos minor hirsutus, siliquâ angustissimâ.* C. B. 332.

XXVIII. *Lunaria vasculo sublongo intorto.* Raij Syn. 164.

XXIX. *Lychnis linifolia torosis & laxioribus capitulis.* Bar. Obs. 64.

XXX. *Majorana Cretica, Origani foliis, villosa, Satureiæ odore, corymbis majoribus albis.* T. Cor. 13. *Origanum Smyrnæum* Wheeleri.

XXXI. *Marrubium Hispanicum supinum, foliis sericeis argenteis.* T: Inst. 192.

XXXII. *Pentaphylloides palustre rubrum.* T. Inst. 298.

XXXIII. *Pentaphylloides fruticosa.* Raij Syn. 142.

XXXIV. *Phlomis fruticosa, Salviæ folio latiore & rotundiore.* T. Inst. 177.

XXXV.

XXXV. *Phlomis fruticoſa, Salviæ folio longiore & anguſtiore.* T. Inſt.

XXXVI. *Phlomis orientalis lutea, anguſtifolia cymis fulveſcentibus.* D. Sherard.

XXXVII. *Phlomis Samia herbacea, Lunariæ foliis.* T. Cor. 10.

XXXVIII. *Ptarmica orientalis pinnulis criſtatis.* T. Cor. *Abſinthium Santonicum Ægyptiacum.* C. B. 319.

XXXIX. *Quinquefolium album majus alterum.* C. B. 325.

XL. *Ruta Chalepenſis, latifolia, florum petalis villis ſcatentibus.* H. L. Bat. 431.

XLI. *Rubus odoratus.* Cornut. 150.

XLII. *Sclarea orientalis, Betonicæ folio acutiſſimo, comâ purpuraſcente.* T. Cor. 10.

XLIII. *Securidaca lutea major.* C. B. 348.

XLIV. *Thlaſpi Halimi folio, ſemper virens.* H. L. Bat. *Alyſſon.* T. 217.

XLV. *Trifolium peltatum Creticum.* C. B. Prod. 142.

XLVI. *Veronica ſpicata hirſuta, folio ſubrotundo ſerrato.*

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L. *Virga aurea altiſſima, ſerotina, paniculâ ſpecioſâ, patulâ.*

II. *Animadverſions*

Philosoph: Transac: N°. 376. Pl: I.

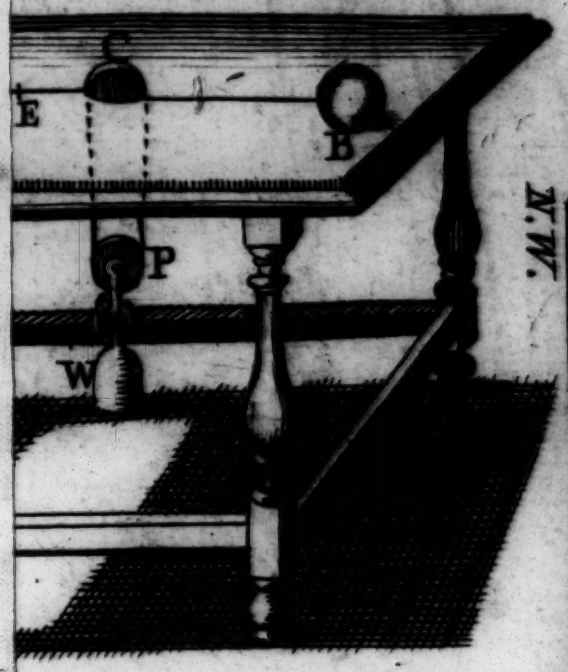


Fig. 3.

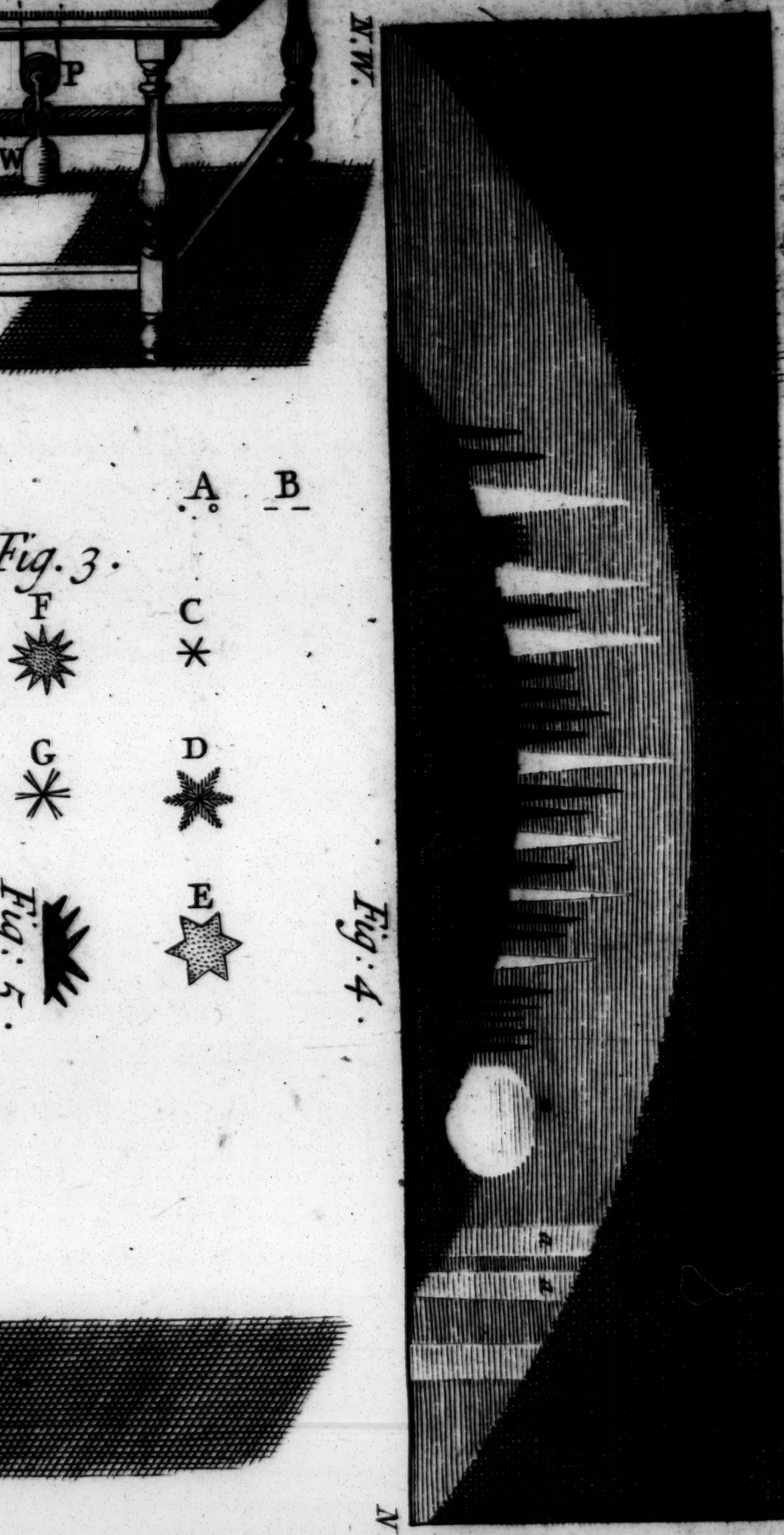


Fig. 4.

Fig. 5.

BRITISH MUSEUM

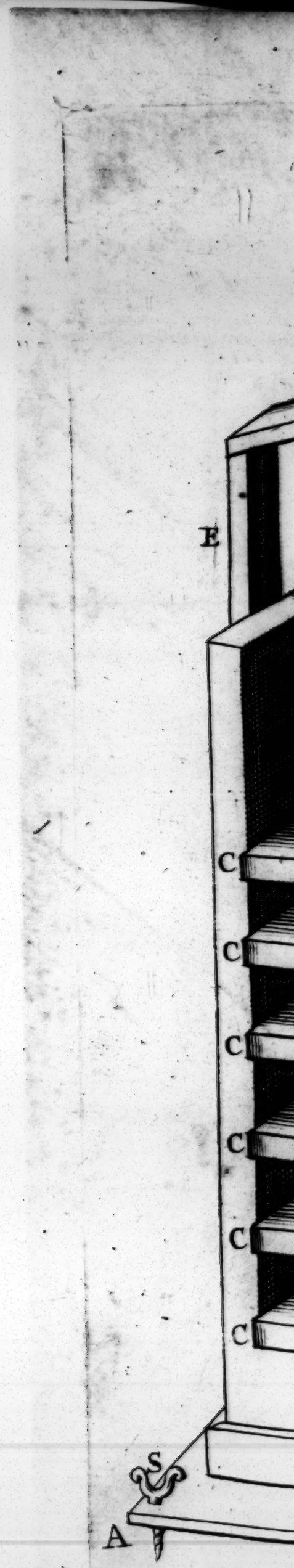

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Fig. 2.

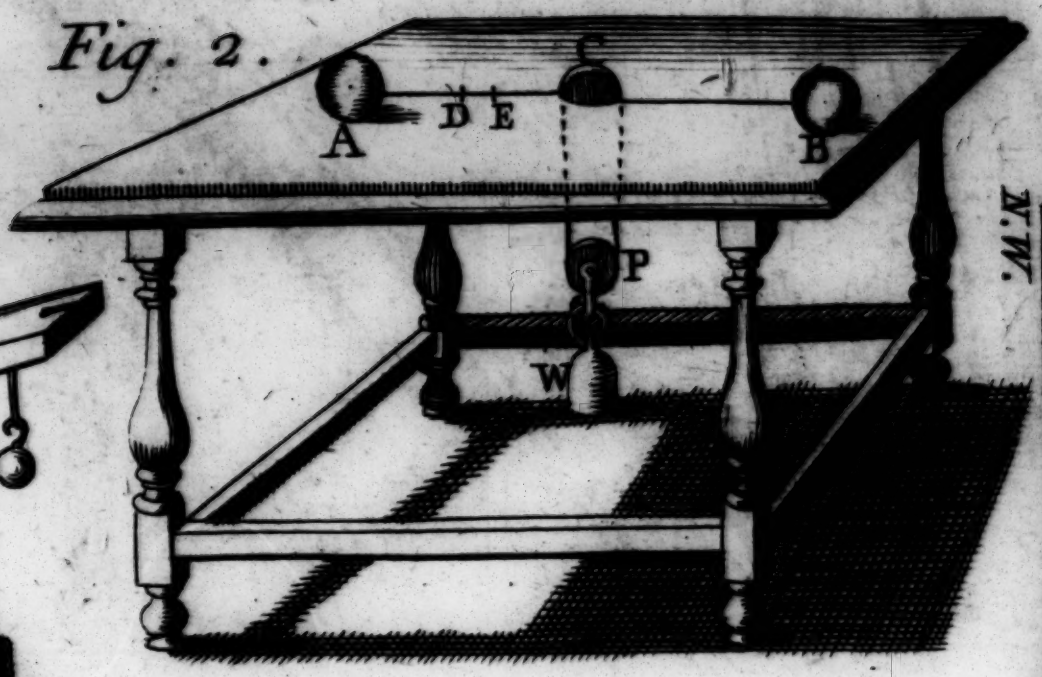


Fig. 1.

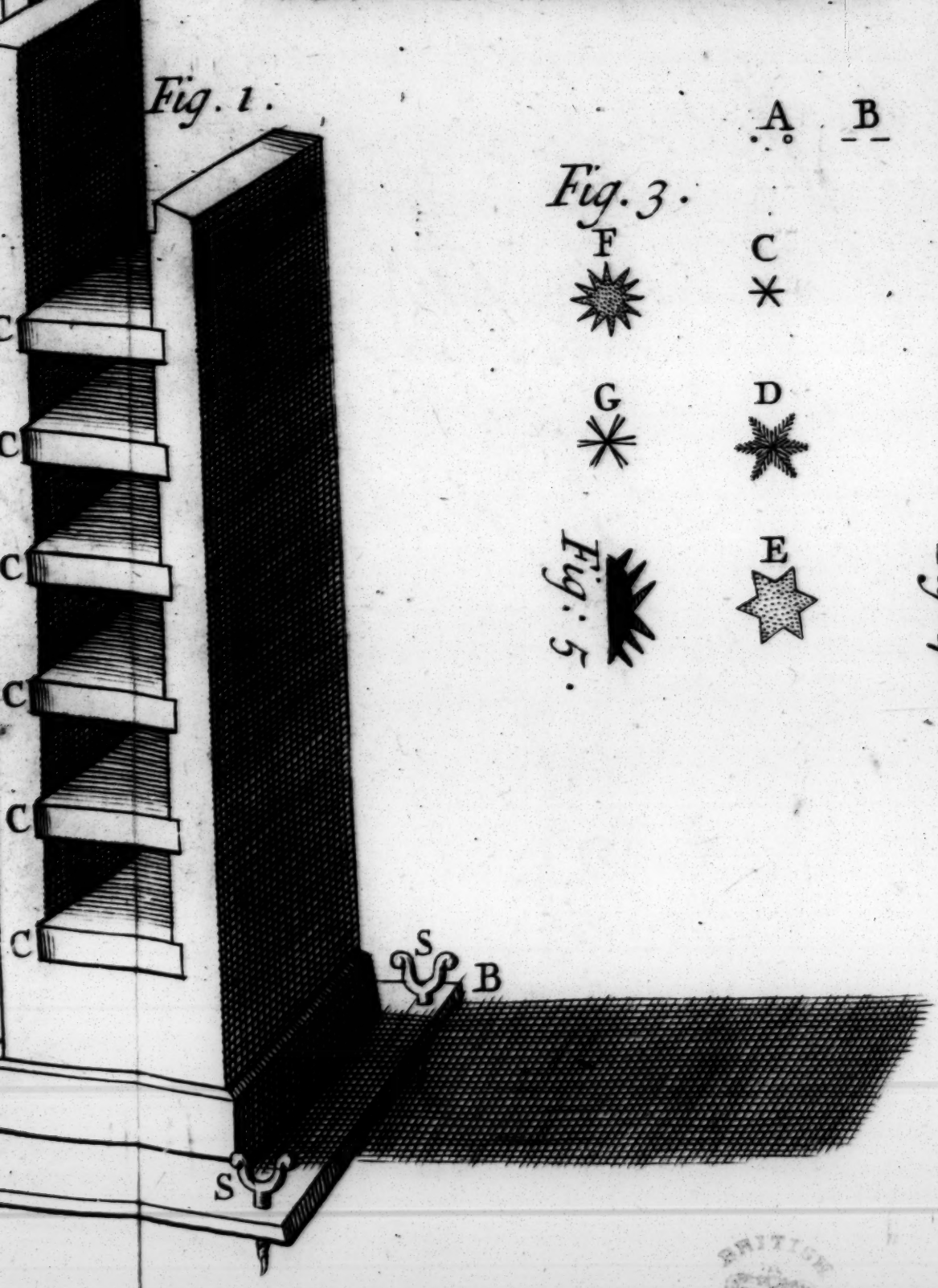
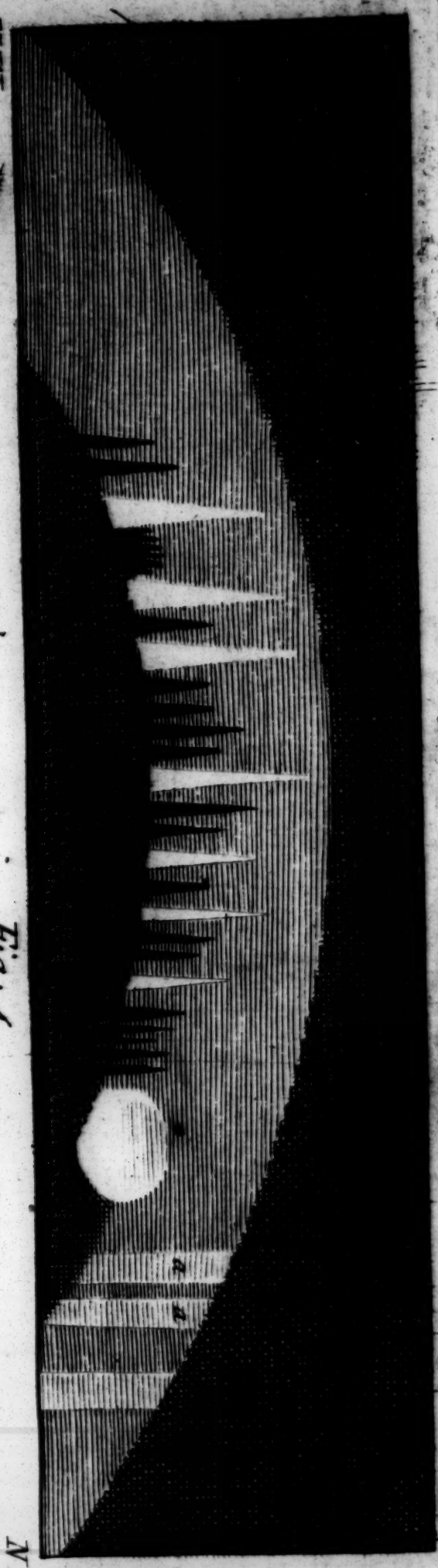


Fig. 3.

Fig. 5.

Fig. 4.



BRITISH MUSEUM

II. *Animadverſions upon ſome Experiments relating to the Force of moving Bodies; with two new Experiments on the ſame Subject.* By the Reverend *Dr.* Deſaguliers, *F. R. S.*

IN a former Paper * I demonſtrated, by Reaſon and Experiments, that the *Momentum*, or Force of moving Bodies, is always proportionable to their Maſs multiplied into their Velocity; as it is the Opinion of the greateſt Part of the Mathematicians and Philoſophers. Now I come to conſider the Experiments, that have led ſome ingenious Men into an Error, in relation to this Propoſition. *Polenus* in his Book † gives an Account of his Experiments relating to this Matter, in theſe Words: " I took a Veſſel, that had in it con-
" geal'd Tallow ſix Inches deep, and fix'd it to a
" level Floor, in ſuch manner, that the Surface of
" the Tallow, which was flat, ſhould every where be
" equally diſtant from the Floor. I had cauſed to be
" made two Balls of equal Bigneſs, the one of Lead,
" the other of Braſs, the laſt of which was a little
" hollow in the middle, that it might weigh but one
" Pound, whilſt the other weigh'd two. Suſpending
" theſe Balls from the Ceiling by Threads, in ſuch
" manner, that the lighter Ball hung over the Surface
" of the Tallow, from twice the Height that the hea-
" vier Ball did; I cut the Threads, and the Balls fal-
" ling perpendicularly upon the Tallow, by their

* *Philoſoph. Tranſ.* No. 375. † De Caſtellis, pag. 56. No. 118.

" Fall made Pits in the Tallow, that were preciſely
" equal: the Ball of one Pound, from the Beginning
" of its Fall, till it came to reſt, going through a Space
" expreſs'd by the Number two, produc'd an Effect
" equal to that, which the two Pound Ball did pro-
" duce, in falling thro' a Space expreſs'd by the Num-
" ber one. It follows therefore, that we may look
" upon it as a ſettled Truth, That the active Forces
" (*vires vivas*) of falling Bodies are then equal, when
" their proper Weights are in a reciprocal *Ratio* of
" the Spaces, which the ſaid Bodies deſcribe by their
" Fall. And becauſe theſe Spaces are in the ſame *Ra-*
" *tio*, as the Squares of the Numbers expreſſing the Ve-
" locities; it appears by the Experiment, that the
" active Force (*vim vivam*) of the falling Body, is
" that which is made up of the Body itſelf, multiplied
" into the Space deſcribed in the Fall, or into the
" Square of the Number, that expreſſes the Velocity of
" the Body, at the end of the Motion. This Experi-
" ment I did not only make once, but ſeveral times,
" changing the Balls, the Diſtances, and the Body on
" which they fell; as for example, making uſe of Clay,
" or of ſoft Wax: and notwithſtanding theſe various
" ways of trying the Experiments, the Effects were
" conſtantly the ſame; which made me eaſily con-
" clude, that there was always the ſame Reaſon in Na-
" ture for this Phenomenon.

Thus far *Polemus*, whoſe Miſtake lies in this; that he eſtimates the Force of the Stroke of the falling Balls, by the Depth of the Impreſſion made in the Tallow, Clay, Wax, or any yielding Subſtance. But we muſt conſider, that when two Bodies move with equal Forces, but different Velocities, that, which moves the ſwifteſt, muſt make the deepeſt Impreſſion, whilſt the ſloweſt Body

Body communicates its Motion to the Clay round about, and therefore does not ſtrike in ſo deep as the ſwifter Body, which puts in Motion few Parts of the Clay, beſides thoſe that are before it, and which Parts have ſo much leſs Time to oppoſe this Body's Motion, as its Velocity is greater than the other's. To make this plainer, Let us ſuppoſe a Door half open, and moving very freely on its Hinges; if a Piſtol be fir'd againſt it, the Ball will go thro' the Door without moving it out of its Place; but if we take a large Weight of Lead, and throw it againſt the ſame Door, with the ſame Force as the Piſtol Bullet mov'd, the Door will be remov'd from its Poſition, and carried out of the Place on its Hinges by the Stroke; becauſe in the firſt Caſe, the Motion of the Ball is communicated but to a few Parts of the Door, and in the laſt it is diffus'd all over it. Nay, the Door will be mov'd by the Stroke, even tho' there ſhould be a prominent Part in the Lead, that ſhould be no bigger than a Piſtol-Bullet, in order to ſtrike the Door upon no more of its Surface, than the Bullet had done.

For illuſtrating this farther I contriv'd the following Experiment.

I caus'd a Machine to be made, as repreſented in *Pl.* I. *Fig.* 1. conſiſting of a Baſe of Wood AB, which could be ſet horizontal by means of three Screws, ſuch as SS: Upon this Board, or Baſe, there ſtood upright two parallel Boards, about four Inches wide, and four Inches aſunder, with the Elbow-piece EF ſliding behind one of them, ſo as to raiſe its upper End F to any Height deſired. Between theſe Boards, ſquare Frames of Wood GG *&c.* with Paper extended upon them, could ſlide in, to the Number of Six, in an horizontal

Poſition. Theſe Paper Diaphragms being thus plac'd, I ſuſpended an Ivory Ball of about one Inch and an half Diameter, weighing ſomething more than an Ounce and an half, by a ſhort Thread, under F, ſo that its Center of Gravity hung four foot over the firſt Diaphragm; then cutting the Thread, the Ball fell upon the Paper, and by its perpendicular Stroke broke thro' that Diaphragm, and the three next under it. Then putting ſo much Lead into the Ball abovemention'd, (which was made hollow for that Purpoſe) as to make it weigh twice as much as it did before; and bringing down F, to let it fall but from one foot, it broke thro' only two Diaphragms by its Fall. Making the Experiment ſeveral times with different Heights, but ſtill keeping the Proportion in Height of four to one, when the Balls were as one and two, the heavy and ſloweſt Ball broke thro' but half the Number of Papers. It happen'd indeed ſometimes, that there was ſome little difference, when the Papers were not equally ſtrong, or equally ſtretch'd, but the ſwifteſt Ball always broke through more Papers than the ſlow one.

Now tho' this Experiment does at firſt ſeem to confirm *Polenus*'s Theory; yet, when duly weigh'd, it proves no ſuch thing. For the lighter Ball does not break thro' more Papers, becauſe it has more Force, or a greater Quantity of Motion, but becauſe each Diaphragm has but half the time to reſiſt the Ball, that falls with a double Velocity, and therefore their Reſiſtance being as the time, as many more of them muſt be broken by the ſwift Ball, as by the ſlow one.

P. S. To all the Objectors, that allow the Force of moving Bodies, and their Quantity of Motion to be the ſame, what has been ſaid in this and my former Paper, ſeems to be a full Anſwer; but as there are now ſome Philoſophers, who diſtinguiſh that Force from the Quantity

Quantity of Motion, I am oblig'd to ſay ſomething more for the clearing up of that Point.

If I underſtand them right, they call *vis viva* a Force, whoſe Effect is ſenſible, as the Force of Gravity, when it accelerates Bodies in their Fall; and *vis mortua* a Force, which being deſtroy'd, produces no ſenſible Effect, as the Force of Gravity acting upon a Weight in one Scale of a Balance, when the Weight cannot deſcend by reaſon of a Counterpoiſe in the other Scale. But certainly no Man, that conſiders the thing attentively, would make that Diſtinction. However, ſince *Polenus* allows, that the Quantity of Motion in Bodies is as the Maſs multiplied into the Velocity (or MV); but ſays, that the Force, with which they act, which he diſtinguiſhes by the Name of *vis viva*, is as the Maſs multiplied into the Square of the Velocity, or MVV: I have made the following Experiment to ſhew his Notion to be inconſiſtent; tho all the *Phænomena* of unequal Weights applied to a *Statera*, ſo as to make an *Æquilibrium*, might ſerve for that Purpoſe, if it had not been objected, that the particular Conſtruction of the Machine hinder'd it from agreeing with the ſuppos'd Theorem, that the Force is as the Matter multiply'd into the Square of the Velocity.

EXPERIMENT.

Let two Balls, A and B, (*Pl.*I. *Fig.* 2.) be joyn'd by a String, which going thro' the ſmooth Hole C of an even Table, and under the Pulley P, ſuſpends a Weight W. It is plain, that upon letting go the Balls A and B, from the Places A and B, they will move towards C with the ſame Force, becauſe each of them will be drawn towards C by half the Force of the Weight W, whether the Balls be equal, or unequal.

1. The

1. The Balls being of two Ounces each (of Ivory), were, at the ſame inſtant of Time, let looſe from A and B, each diſtant twelve Inches from C, and both came to C at the ſame Time. Here the equal Forces will agree with the Product of the Maſſes into the Velocities, or into the Squares of the Velocities; becauſe $A \times 12 = B \times 12$, as well as $A \times 144$ is equal to $B \times 144$.

2. If A be taken of four Ounces Weight, and let go from D, or ſix Inches, whilſt B, ſtill equal to two, moves from 12 Inches; both Bodies will again meet at C: therefore here the equal Forces muſt be expreſs'd by the Maſſes into the Velocities, and not into their Squares; for tho' $A \times 6$ be equal to $B \times 12$ ($4 \times 6 = 2 \times 12$), $A \times 6 \times 6$, or 144 is but half of $B \times 12 \times 12$, or 288. Whereas if the Forces had been as *Polenus* affirms, B ſhould have been let looſe only from 8,4 Inches.

3. When A is ſix Ounces, it is let looſe only from E, or 4 Inches, to meet at C with B let looſe from 12; for then $A \times 4 = B \times 12$, whilſt $A \times 4 \times 4$, or 96, is three times leſs than $B \times 12 \times 12$, or 288. So that according to *Polenus*, B muſt have been let looſe from 7; but in that Caſe it comes ſooner to C than A.

N. B. The Weight W muſt be greater than the Weight of both Balls, leaſt the Friction of the Table ſhould ſpoil the Experiment.

III. *An*

III. *An Account of an Experiment, made to aſcertain the Proportion of the Expanſion of the Liquor in the Thermometer, with Regard to the Degrees of Heat.* By Brook Taylor, *LL.D. R.S.S.*

IT has, I believe, been generally ſuppoſed, tho' not proved, that the Expanſion of the Liquor in the Thermometer, is proportional to the Increaſe of Heat. To determine this Matter with Certainty, I made the following Experiment.

I provided a good Linſeed Oil Thermometer, which I marked with ſmall Diviſions, not equal in Length, but equal according to the Capacity of the Tube in the ſeveral Parts of it, as all Thermometers ought to be graduated. I likewiſe provided two Veſſels of thin Tin, of the ſame Shape, and equal in Capacity, containing each about a Gallon. Then (obſerving in every Trial, that the Veſſels were cold, before the Water was put in them, as alſo that the Veſſel I meaſured the hot Water with, was well heated with it) I ſucceſſively fill'd the Veſſels with one, two, three, *&c.* Parts of hot boiling Water, and the reſt cold; and at laſt with all the Water boiling hot; and in every Caſe I immerſed the Thermometer into the Water, and obſerved to what Mark it roſe, making each Trial in both Veſſels for the greater Accuracy. And having firſt obſerved where the Thermometer ſtood in cold Water, I found that its riſing from that Mark, or the Expanſion of the Oil, was accurately proportional to the Quantity of hot Water in the Mixture, that is, to the Degree of Heat.

IV. *An Account of the Rattlesnake. By the Honourable* Paul Dudley, *Esq*; *F. R. S.*

THE Rattlesnake is reckoned by the *Ab-origines*, to be the most terrible of all Snakes, and the Master of the Serpent-kind; that which causes their Terror, without doubt, is their mortal Venom, and the Ensign of it is their Rattle; and it is most certain, that both Men and Beasts are more afraid of them, than of other Snakes; and while the common Snake avoids a Man, this will never turn out of the Way.

There are three Sorts, or Kinds, of this Snake, and distinguished by their Colour, *viz.* a yellowish Green, a deep Ash Colour, and a black Sattin.

The Eye of this Creature has something so singular and terrible, that there is no looking stedfastly on him; one is apt, almost, to think they are possest by some Demon.

A Rattlesnake creeps with his Head close to the Ground, and is very slow in moving, so that a Man may easily get out of his Way: This ought to be remarked as an Instance of the Goodness of God, who preserves Man and Beast. His leaping and jumping to do Mischief, is no more than extending, or uncoiling himself; for they don't remove their whole Body, as other Creatures do, when they leap; so that a Man is in no Danger of them, if his Distance be more than their Length; neither can they do any Harm when they are in their ordinary Motion, until they first coil

and

and then extend, or uncoil themſelves, but they both are done in a Moment's Time.

When a Rattleſnake reſts, or ſleeps, he is coiled, and they are obſerved to be exceeding ſleepy.

Our People at firſt took the Noiſe this Creature makes, to be owing to ſome little Bones, or hard looſe Kernels lodged in their Tails; but ſoon diſcovered their Miſtake, and found the Tail to be compos'd of Joints, that lap over one another, ſomewhat like a Lobſter's Tail; and the ſtriking them one upon another, forms that Noiſe, which is ſo terrible to Man and Beaſt. The fierceſt Noiſe is obſerv'd to be in clear fair Weather, for when 'tis rainy, they make none at all; for which Reaſon, the *Indians* don't care to travel in the Woods, in a Time of Rain, for fear of being among theſe Snakes before they are aware. One other Circumſtance of their rattling has been obſerv'd, to wit, that if a ſingle Snake be ſurprized and rattles, and there happen to be others near him, they all take the Alarm, and rattle in like manner.

I dare not anſwer for the Truth of every Story I have heard, of their charming, or Power of Faſcination; but yet I am abundantly ſatisfied from many Witneſſes, both *Engliſh* and *Indian*, that a Rattleſnake will charm both Squirrels and Birds from a Tree into his Mouth. A Man of undoubted Probity ſometime ſince told me, that as he was in the Woods, he obſerv'd a Squirrel in great Diſtreſs, dancing from one Bough to another, and making a lamentable Noiſe, till at laſt he came down the Tree, and ran behind a Log: The Perſon going to ſee what was become of him, ſpied a great Snake, that had ſwallow'd him.

And I am the rather confirmed in this Relation, becauſe my own Brother, being in the Woods, opened one of theſe Snakes, and found two ſtrip'd Squirrels in

his Belly, and both of them Head foremoſt. When they charm, they make a hoarſe Noiſe with their Mouths, and a ſoft Rattle with their Tails, the Eye at the ſame time fixed on the Prey.

Their general Food conſiſts of Toads, Frogs, Crickets, Graſshoppers, and other Inſects, but principally of Ground Mice; and the Rattleſnake again ſerves for Food to Bears, and even our Hogs will eat them without Harm.

They are viviparous, and bring forth generally about twelve, and in the Month of *June*. A Friend of mine in the Country, being deſirous to diſcover the Nature and Manner of the Generation of the Rattleſnake, gave me the following Account, *viz.* About the middle of *May*, the Time when the Rattleſnakes firſt come abroad, he took and opened one of them, and in the *Matrix* found twelve ſmall Globes, as big as a common Marble, in Colour like the Yolk of an Egg; in three or four Days more, he took and opened another, and then plainly perceived a white Speck in the Centre of the yellow Globe; in three or four Days more, he diſſected a third, and diſcovered the Head of a Snake; and in a few Days after that, three Quarters of a Snake was formed, and lying round in a Coil. In the latter End of *June*, he kill'd an old one, and took out perfect live Snakes of ſix Inches long. In *September*, when the old ones take their Young in, and carry them to their Dens, they are not quite a Foot long. They couple in *Auguſt*, and are then moſt dangerous.

I cannot ſay, what other Serpents, or poyſonous Creatures, may do, but I am ſatisfied the Rattleſnake does not traject his Poyſon; and that unleſs the Skin be firſt broke, or an Inciſion made with his Teeth, his Venom can do no Harm; for my Friend aſſured me, that he had made an Experiment of it in this manner: He took

the

the Breech of his Gun, and ſet it upon four or five of them, and after they had bit it, and left ſeveral Drops of their Poyſon, he with his Hand wiped it off without any Harm.

Our People have ſeveral Remedies for the Sting of a Rattleſnake; among others, that which is much made uſe of, is a Root they call Blood-root, I ſuppoſe ſo named, from the Colour of the Root, and the Juice, which is red like Blood. It grows in great Abundance in our Woods; they bruiſe the Root, and bind it above the Place that is bit, to prevent the Poiſon's going farther, at the ſame Time ſcarifying the Place affected; ſome of the Root is alſo boiled, and the Perſon poiſoned drinks the Water.

They are generally from three to five Feet long, and do not commonly exceed twenty Rattles; and yet I have it atteſted by a Man of Credit, that he killed a Rattleſnake, ſome Years ſince, that had between ſeventy and eighty Rattles, with a ſprinkling of grey Hairs, like Briſtles, over his Body; he was full five Foot and an half long, and as big as the Calf of a Man's Leg.

They ſhed, or throw off their Skins every Year, ſometime in the Month of *June*, and turn it inſide out when they throw it off. It has alſo been obſerved, that the Skin covers not only the Body, but the Head and Eyes.

They generally den among the Rocks in great Numbers together; the Time of their retiring is about the middle of *September*, and they don't come abroad till the middle of *May*, when our Hunters watch them, as they come out a ſunning, and kill them by hundreds.

Roxbury, New-England,
Octob. 25. 1722. *Paul Dudley.*

V. *Some Obſervations upon Vipers; on occaſion of the foregoing Relation.* By C. J. Sprengell, M. D. F. R. S.

AT *Milan* I found a Viper-Catcher, who ſeldom was without 60, or more, Vipers alive, kept together in a back Room open at the Top; he had them from all Parts of *Italy*, and ſold them dead or alive, according to the Uſes they were deſigned for. He having got one day a female Viper big with young, gave me notice to ſee her manage her Prey; whereupon we catch'd ſome Mice, and throwing them in one at a Time, amongſt all that Number of Vipers, (which were rather above 60) there was none of them, that in the leaſt concern'd himſelf about the Mouſe, till the laſt mention'd pregnant female Viper and the Mouſe interchanged Eyes; whereupon the Mouſe ſtartled, but the Viper rais'd her Head, and turn'd her Neck into a perfect Bow, the Mouth open, the Tongue playing, the Eyes all on Fire, and the Tail erect. The Mouſe ſeem'd ſoon recover'd of his Fright, would take a Turn or two, and ſometimes more, pretty briſkly, round the Viper, and giving now and then a Squeak, would run with a great deal of Swiftneſs into the Chops of the Viper, where it gradually ſunk down the Gullet. All this while the Viper never ſtirr'd out of its Place, but lay in a Ring.

It is to be obſerv'd, that no Viper will feed, when confin'd, except a female Viper impregnated.

The ſame I ſaw at *Bruſſels*, where a Soldier had catch'd a large Viper big with young. The Houſe, where I and ſome of my Companions lodged, was near the Fiſh-Market, where my Landlord had a Sow, and five ſmall Pigs of nine or ten Days old. We got one of the Pigs, which we caus'd to be bit by the Viper in the Tail, and in four Minutes time chopp'd off the Tail, the Pig appearing to be ſick and dizzy, and the remaining part of the Tail being ſwell'd; but I believe the bleeding ſav'd it, for the next Morning it was well again. The ſame happen'd to another Pig, which we had got bit in the fore Foot, and ſtaying ſeven Minutes after the Bite, cut off his Leg about two Inches above the Bite. After theſe two, we took the other three, and had them bit in ſeveral Places, whereof two died that Night, and the third recover'd, we having given it, about five or ſix Minutes afterwards, ten Grains of Emetic Tartar.

This I try'd afterwards upon Dogs bit by Vipers, and I found that they all recover'd upon the Emetic Tartar.

VI. *Obſer-*

VI. *Obſervations on the Figures of Snow. By the Reverend* Benj. Langwith, *D. D. Rector of* Petworth *in* Suſſex. *In a Letter to Dr.* Jurin, *R. S. Secr.*

ON the 30th of *January* laſt, ſomething paſt Nine in the Morning, Weather cold, Wind South-weſterly, but not very high, Barometer above thirty Inches, I ſaw that pretty Phenomenon of the Star-like Snow, and tho', upon comparing my Obſervations afterwards with thoſe of *Deſcartes*, Dr. *Grew*, and Mr. *Morton*, I find I have but little to add upon the Subject; yet, as I obſerv'd the Progreſs of Nature in this ſort of Cryſtallization, with a great deal of Pleaſure, I hope it will not be diſagreeable to you to receive an Account of it.

I ſhall begin with the moſt ſimple Figures A and B, (*Pl.* I. *Fig.* 3.) of which the former is a roundiſh Pellet of Ice; the ſecond, a ſmall oblong Body, with parallel Sides, which is often as fine as a Hair. Of this latter kind the Flakes of Snow chiefly conſiſt; and tho' they look white to the Eye, yet when view'd with a ſmall Magnifier of a Microſcope, they appear like ſo many tranſparent Needles of Ice thrown together, without any Manner of Order.

The next Figure is C, in which the Pellet has ſhot out ſix of thoſe ſmall Bodies of equal Length, and ſet at equal Angles: Of this kind I ſaw a conſiderable Number.

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The next Step in the Cryſtallization is D, in which thoſe Bodies are lengthen'd, and have ſhot out a great many more from their Sides, at equal Angles, but unequal Lengths, as growing continually ſhorter and ſhorter, till they terminate in a Point: I meaſur'd ſome of theſe, and found them to be about one quarter of an Inch in Breadth. I ſaw but very few of them in Perfection, for the collateral Shoots were ſo exquiſitely fine, as to be liable to be broken in their Fall, or confounded together by the leaſt Degree of Heat.

Of the next kind, E, I ſaw a very great number, which being examin'd by the Microſcope, plainly appear'd to be nothing but the former in Diſorder. The Edges of theſe were in general very irregular, but ſome of them happened to be ſo indented, as to look like the jagged Leaves of Plants.

The next Kind, F, had twelve points regularly diſpoſed, and probably might conſiſt of two of the former ſo join'd together, as to cut their Angles equally.

Perhaps alſo thoſe Mr. *Morton* deſcribes, as conſiſting of *Radii*, which, inſtead of terminating in a Point, grow bigger, as they advance from the Centre, might be formed from two of the Kind, C, ſo join'd at the Centre, as to cut each other's Angles unequally; for in the Progreſs of the Cryſtallization, theſe *Radii* would quickly unite.

Laſtly, that Sort, which *Deſcartes* compares to Roſes, and of which he has given a Figure in his Treatiſe of Meteors, may be nothing but the Kind E, when the Points are rounded off, by being gently thaw'd.

I propoſe theſe things only by way of Conjecture; becauſe, as the ſmall Drops of Water may be impregnated with very different Particles in the Air, it is not eaſy to determine, whether theſe Figures may not be the Reſult

Reſult of a Cryſtallization quite different from the former.

I had almoſt forgot to tell you, that I ſaw but very few Figures of twelve Points, and thoſe moſtly imperfect in one reſpect or other.

Petworth, Feb. 13. 172$\frac{2}{3}$.

VII. *Obſervationes Auroræ Borealis per quadriennium factæ*, Lennæ Regis *in* Norfolciâ. *Ex epiſtolâ doctiſſimi Obſervatoris ad* Martinum Folkes, *Arm. Reg. Soc. Vice-Præſ.*

NON ingratum fore arbitror, Vir Doctiſſime, obſervationes quaſdam de Aurorâ Boreali, apud Lennam Regis in Norfolciâ, quatuor ſuperioribus annis a me habitas tibi impertire. Mirum illud Phænomenon ſexto Martii 171$\frac{5}{6}$. non licuit mihi inſcienti videre, quod infortunium haud exiguum in me peperit ſtudium ſubſequentibus Phænomenis invigilandi. Priorem obſervationem, quam hic ſubjeci, ſummâ curâ delineavi, ſtatim atque vidi, ideoque, ni fallor, a vero parum diſcrepat. Reliquas etiam deſcriptiones pro certo habeas accuratas eſſe. Quænam ſit cauſa harum coruſcationum, nondum, ut opinor, ſatis exploratum eſt.

Die Veneris Sept. 5. 1718. circa hor. x. Phænomenon hoc, delineatum *Pl.* I. *Fig.* 4. obſervatum fuit Lennæ Regis, in puncto boreali.

Die

Die Saturni Sept. 6. circa horas VIII & X. perplures Luminis columnæ, ſimiles ſupradeſcriptis (*aa*) obſervabantur, non æque lucidæ ac pyramides nocte præcedente obſervatæ, quæ ferebantur verſus orientem, hæ vero ad occidentem.

Die Jovis Sept. 11. perplures iſtiuſmodi columnæ iterum conſpiciuntur cum motu occidentali.

Die Saturni Sept. 13. circa horam XI. Aurora Borealis lucidior ac altior fuit, longioribuſque pyramidibus adornata, quam adhuc obſervata fuerat. Adeo lucebat hâc nocte, ut characteres in libro legerentur.

Die Saturni vero Octob. 11. circa horas X & XI. Aurora Borealis lucidior quam unquam fuit, ac coruſcationibus pyramidalibus interſperſis, haud multum abſimilis Phænomeno prius obſervato, Sept. 5. Lumine iterum ita ſplendente, ut legere liceret.

Die Veneris Dec. 19. circa horas VIII & IX. Hâc nocte viſi ſunt cum Aurorâ Boreali perplures lucis radii, e nube veluti nigrâ exorientes; revera autem non fuiſſe nubem exinde patet, quia ſtellæ per illam clare videbantur. Quid vero aliud fuerit, haud facile eſt dictu. Sed quod præcipue notavimus, fuit motus horum luminum ſane mirabilis. Hos radios obſervavimus in ſtatu ſemper mobili, poſitiones ſuas, ſeu loca, perpetuo mutantes; curſum ſuum modo hâc, modo illâc, rurſum, prorſum dirigebant, & interdum alii ex aliis eâdem viâ ſingulatim progreſſi ſunt, & aliquandiu ſibi invicem colliſione mutuâ impingebant cum tremulo ac vibrante motu, & celeritate fere incredibili. Radii quidam obſervati ſunt uſque ad Zenith ſe porrigentes. Viſa eſt ſæpe lux ſe in acervum collegiſſe, atque ita mirum exhibuiſſe fulgorem coloribus Iridis tinctum, & iterum viſa eſt ſe dilatâſſe. Luna hâc nocte lucide ſplendebat.

Die Jovis Martii 12. $17\frac{18}{19}$. circa horas X & XI. Aurora Boreâlis rurſus obſervabatur.

Die Veneris Martii 27. iterum visa est Aurora Borealis cum radiationibus variis obliquis, secundùm hanc Figuram. *Pl. I. Fig. 5.*

Die Lunæ Octob. 26. 1719. hâc nocte etiam visa est circa horas VII & VIII.

Item die Lunæ Nov. 9. 1719.

Die Domin. Jan. ult. $17\frac{19}{20}$. Hâc nocte, ab horâ septimâ usque ad decimam, Aurora Borealis visa est altior, quam unquam antehac observata fuit, per dimidium cœli ab oriente usque ad occidentem, fere obducta coruscationibus variis interspersis, adeoque lucebat, ut characteres in libro perquam distincte videri possent.

Die Saturni Sept. 17. 1720.

Die Lunæ Jan. 6. $17\frac{20}{21}$. circa horas VII & VIII. visa est iterum Aurora Borealis cum coruscationibus pyramidalibus, undique a Zenith, veluti centro, obductis, imaginem exhibentibus pæne instar Umbellæ.

Die Domin. Jan. 12. $172\frac{0}{1}$.

Die Lunæ Sept. 11. 1721. circa hor. IX.

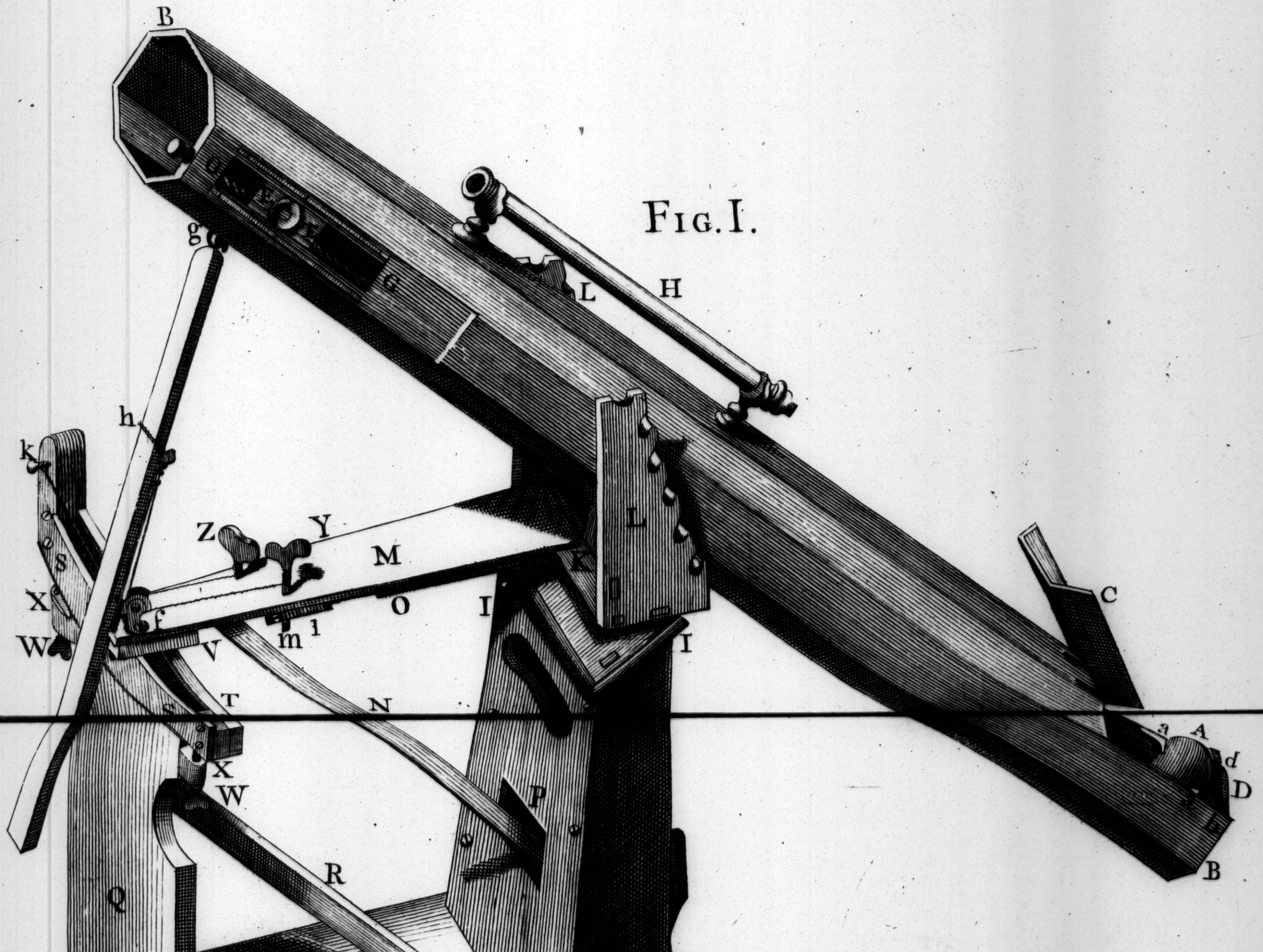
Die Mercurii Sept. 5. 1722. ab horâ decimâ ad sesquidecimam.

Die Mercurii Octob. 3. circa hor. IX.

Die Jovis Octob. 4. circa hor. X.

Die Domin. Dec. 23. 1722. circa hor. VIII.

FIG. I.





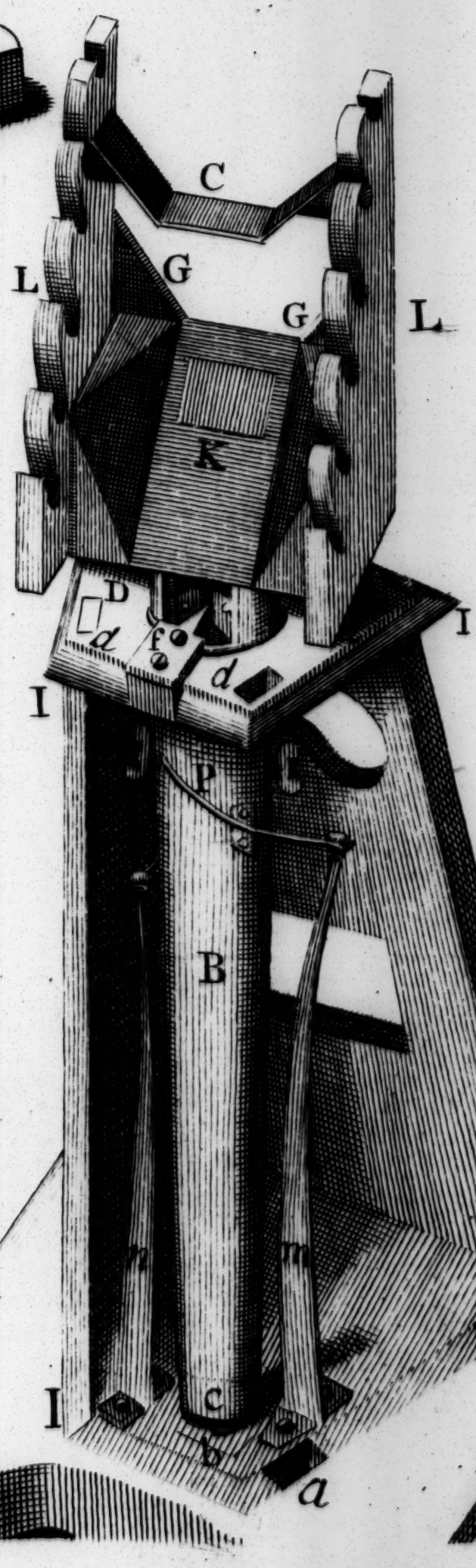


FIG. III.

FIG. II.

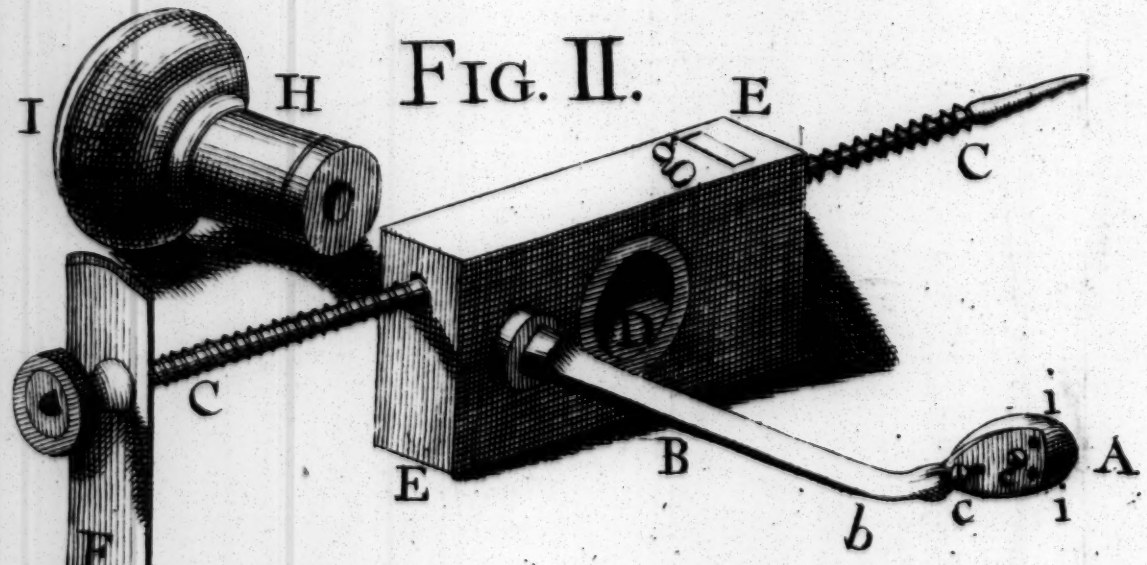
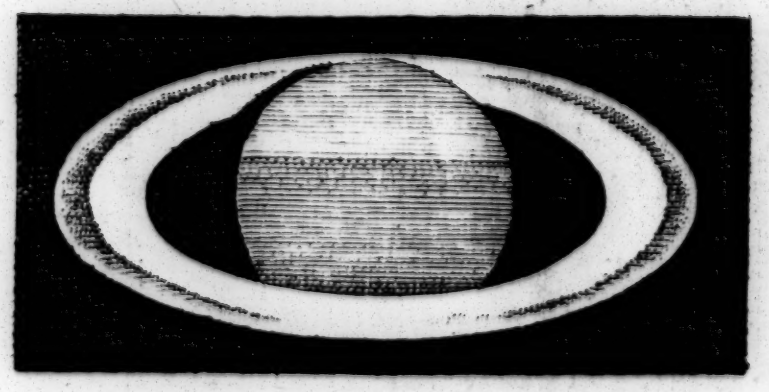


FIG. IV.



I. Sturt sculp.

BRITISH MUSEUM

VIII. *An Account of a Catadioptrick Teleſcope, made by* John Hadley, *Eſq; F. R. S. With the Deſcription of a Machine contriv'd by him for the applying it to uſe.*

THE Inſtrument conſiſts of a metalline *Speculum*, about ſix Inches in Diameter. The *Radius* of the Sphere, on which its concave Surface was ground, is ten Feet, five Inches and one quarter, and conſequently its focal Length is 62 ¼ Inches. The Back has a hollow Screw made at its Centre, to receive the End of a Handle, which is ſcrew'd on, whenever the Metal is to be moved, in order to avoid ſullying its poliſh'd Surface by handling.

This Object-Metal A, *Pl.* II. *Fig.* 1. is placed in one End of an octangular Tube, B B, about ſix Feet long, and ſomething wider than what is ſufficient to receive the Metal, dyed black on the Inſide. About ſix or ſeven Inches in Length of the three uppermoſt Sides of the Tube C, (toward that End, at which the Metal is plac'd) are ſeparated from the reſt, and open with two Hinges, to make room for the Metal to be put in and taken out. The End of the Tube is cloſed by an octangular Piece of Board D, which has an opening *d*, about ⅔ of an Inch broad, from the Top down to a little below the Centre, to give room for the beforemention'd Handle, when the Object-Metal is lifted into or out of the Tube; at other times it is cloſed with a ſliding Shutter. The

Metal is placed ſo, as to have its *Axis* coincide with that of the Tube, by the means of three ſmall Buttons fix'd to the Inſide of the Tube, having their hinder Ends all in the ſame Plane, to which this *Axis* is perpendicular. Two of theſe appear at *a a*, the third being at the middle of the Bottom of the Tube, is not ſeen. The foreſide of the Metal reſts againſt theſe Buttons in three Points of its Circumference, nearly equidiſtant from each other, and is held to them by three Screws, (one of which appears at *b*) which run through the octangular Board at the End of the Tube, and bear againſt the Back of the Metal, (in three Points, which directly anſwer thoſe three on the foreſide) with juſt ſo much Force, as is requiſite to keep it ſteady in its Place. They muſt not be ſcrew'd harder againſt the Metal for Fear of bending it, which (tho' it is half an Inch in Thickneſs) a very little Force is ſufficient to do. When the Inſtrument is not uſed, theſe Screws are looſen'd, and the Object-Metal is taken out and laid by, to prevent its tarniſhing.

The oval Plane is compos'd of a Plate of the ſame Metal with the great *Speculum*, about $\frac{1}{15}$ or $\frac{1}{16}$ of an Inch in Thickneſs, ſolder'd on the Back to another of Braſs. Its Breadth is ſomething leſs than half an Inch, and is in Proportion to its Length as 1 to $\sqrt{2}$. At one End of the Oval, the Braſs Plate projects a little beyond the other, and has a Screw cut through it in that Part, as likewiſe another directly againſt the Centre of the foreſide. The other End is cypher'd away on the Backſide, that it may intercept as few of the Rays, in their Paſſage towards the Object-Metal, as is poſſible. The two Screw-holes in the Back ſerve to fix this Oval A, *Fig.* 2. to a Braſs Arm, B, which is faſtened at the other End into a Slider EE. *Fig.* 1. and 2. This

Slider

Slider is of an equal Thickneſs with the Side of the Tube, and has a Groove, G G, *Fig.* 1. cut for it in that Side, parallel to the *Axis*, and long enough to give room for its Motion, to ſet the two *Specula* at the different Diſtances, which the ſeveral Eye-Glaſſes require. It reſts on the Inſide againſt two thin Ledges, faſtened within the Tube along the Sides of the Groove. On the Outſide it is kept in its Place by a ſliding Shutter, not expreſſed in the Figure. In the Middle it has a Cylindrick Cavity, D, *Fig.* 2. whoſe *Axis* is exactly perpendicular to its inner and outer Surfaces. Each of the Boxes, in which the Eye-Glaſſes are contained, is fitted to this Cavity. The beformention'd Braſs Arm is fix'd into the Inſide of this Slider, towards the End fartheſt from the Object-Metal; it riſes perpendicular for about two Inches, and is made flat, ſo as to turn one Edge to the Rays, which come from the Object. About *b*, it is bent forwards and flatted the other Way, ſo that when the Back of the oval Plane is held flat to it, by the two Screws *c c*, the Axis of the Cylindrick Cavity may fall on the Centre of its foreſide, inclin'd to its Surface in an Angle of ſomething leſs than fourty five Degrees. This Angle is brought to be exact by two very ſmall Screws, *i i*, whoſe Threads take hold in the flatted End of the Braſs Arm, and their Points bearing againſt the Back of the Oval, raiſe one End of it a little from the flat of the Arm. The *Specula* are ſet at their due Diſtance, by turning of a long Screw, C C, for which there is a Nut lodged in the Slider at *g*; the Screw is kept from moving backward or forward, when 'tis turned, by a Braſs Plate, F, which is to be fix'd to the flat End of the Side of the Tube, and taken off at Pleaſure. Each of the Eye-Glaſs Boxes, H, has a Screw on the outward End, to faſten to it a Bowl, or

Diſh

Diſh, I, to receive the Ball of the Eye, and guard it from external Light.

On the Top of the Tube is fix'd, on two ſmall Pedeſtals, a common Dioptrick Teleſcope, H, *Fig.* 1. about eighteeen Inches long, its *Axis* parallel to that of the Tube; and having two Hairs plac'd in the common *Focus* of its Object and Eye-Glaſſes, croſſing one another in its *Axis*.

There are three convex Eye-Glaſſes belonging to the Inſtrument. The firſt, or ſhalloweſt, has its focal Diſtance of about $\frac{1}{3}$ of an Inch; the ſecond, of $\frac{3}{10}$; and the deepeſt, of $\frac{11}{40}$, or ſomething leſs. When the firſt of theſe is uſed with the Inſtrument, it magnifies about 188, or 190 times, in Diameter; with the ſecond, about 208; and with the third, 228 or 230. Each of theſe Glaſſes has placed, in that *Focus* neareſt the Oval, a Circle to determine the Part of the Object ſeen at one View; and in the other *Focus* toward the Eye, a Braſs Plate with a little Hole in the middle, to let no Light paſs to the Eye from the Inſide of the Tube, but what comes from the Oval. Beſides theſe three convex, there are two concave Eye-Glaſſes, with which it magnifies about 200 and 220 times; and alſo a Sett of three Convex, which turn it into a Day Teleſcope, magnifying about 125 times. The Aperture is limited by a Circle of Card, or Paſtboard, placed before the Object-Metal in the Tube. To vary the Aperture there are three of theſe Circles, and the Apertures allowed by them are five Inches and an half, five Inches, and four and an half, tho' for ſome Objects the whole Metal may be left open.

The Engine made uſe of to direct the Tube to any Object, conſiſts of a ſtrong Plank, F F, *Fig.* 1. and 3. about fourteen Inches wide, and two Feet and an half, or three Feet long, which ſerves as a Foundation for the

the whole. Near one End of this Plank is placed an upright fourſided Box, III, *Fig.* 1. and 3. about two Feet high, narrower at the Back next the End of the Plank than before: Its two Sides are mortiſed both into the Plank below, *a a*, *Fig.* 3. and into the Top of the Box above, *d d*; the back and fore Part are faſten'd to the Edges of the Sides with Wood-Screws. The Top has a circular Hole cut in it, ſomething above three Inches in Diameter, whoſe Centre is about three Inches diſtant from the outſide of the Back, and at an equal Diſtance from the two Sides. This Hole gives Paſſage to a turning Pillar B, in the Bottom of which there is fix'd an Iron Pivot *c*, to turn in a thick Braſs Plate lodged in the Plank, *b*. The upper End of the Pillar riſes about an Inch and an half above the Top of the Box, and is mortiſed into a ſtrong Head, K, *Fig.* 1. and 3. about eight Inches in Length, and four or five in Breadth and Thickneſs. This Head carries two Cheeks, L L, about thirteen or fourteen Inches in Height, their hinder Edges, towards the lower End, extending five Inches beyond the *Axis* of the Pillar backward. Along the Back of theſe Cheeks, at equal Diſtances above one another, there are Notches, tending obliquely downwards, and anſwering one another in each Cheek, to receive the Pivots of a crooked Iron *Axis*, C, *Fig.* 3. on which the Tube is plac'd. The Notches are made at different Heights, to keep the Eye-Glaſs at a proper Height for the Eye, in different Elevations of the Object above the Horizon. The Figure of the *Axis* anſwers that of the three under Sides of the Tube. The *Axis* of the Tube lies about two Inches and an half higher than the *Axis* of the Motion upon theſe Pivots, and the Centre of Gravity, when the Object-Metal is in, is about three Inches backwarder. To keep the Tube from ſlipping back, when its fore End is raiſed, it has

two

two Buttons fixed to it, which reſt againſt the fore Part of the *Axis*.

To keep the Pillar from touching any of the Sides of the round Hole, in which it turns, a Cylindrick Sector, containing about 65° or 70°, and about an Inch in Height, is cut out on the back Part of the Pillar, near the upper End D. In the ſquare Angle of this Cavity is fix'd a thin Steel Plate *oo*, bent croſs the middle to the ſame Angle. The internal angular Edge, between the two Parts of this Plate, lies in the *Axis* of the Pillar, and turns upon the harden'd Edge of a Wedgelike Iron, *f*, whoſe Baſe, or Board Part, is faſten'd with two ſtrong Screws on the Top of the Box, directly behind the round Hole beforemention'd.

The upper Parts of the Cheeks are ſtrengthened by two Brackets, GG, leaving Room between them for the Bottom of the Tube to touch the upper Edge of the fore Part of the Head. The hinder Part of the Head is alſo hollow'd, in the Manner repreſented in the third Figure.

The Head on its fore Part carries a flat Arm, M, *Fig.* 1. about twenty ſeven Inches long, a little taper towards the farther End, where it is four Inches broad. This is ſtrengthened by a narrow Slip, glew'd edgewiſe along the middle underneath, O, and alſo by a Brace or Stay, N, reaching from the turning Pillar to within nine Inches of the End of the Arm. The Stay paſſes through a tranſverſe opening cut in the fore Part of the Box, P, which is long enough to allow room for a ſufficient Motion of the Pillar round its *Axis*.

On the other End of the Bottom Plank, tranſverſely to its Length, is erected a Board about twelve Inches wide, and twenty ſix or twenty ſeven high, Q, the Top of it reaching within an Inch and an half of the under Side of the Arm. This Board is held firm in its

Poſition by a Spur, R, part of its upper End on the outſide is pared off toward the Edges, to form it into the Segment of a Cylinder, whoſe *Axis* coincides with that of the Pillar. Its Uſe is to ſupport a Reſt, SS, on which the End of the flat Arm moves backward and forward. This Reſt being apply'd tranſverſely to the outer Part of the upright Board, where it is made Cylindrick, is bent into the ſame Figure, by the means of four Screw-Pins, two of which paſſing through each End of this, and of another Piece of the ſame Length, T, (but ſomething narrower) placed over againſt it on the inſide of the Board, by their Nuts, draw them together, ſo as to graſp the End of the upright Board between them; the upper Edge of the Reſt being firſt ſhot with a Plane very ſtrait and ſmooth. To render the Motion of the Arm along the Reſt ſmooth and eaſy, it has two Rollers lodged in a Box fix'd near to the End, on its underſide, V, to roll upon the Edge of the Reſt, when the End of the Arm is moved along it. One of the Rollers is placed near each Edge of the Arm, and their *Axes* lye in Lines paſſing through the *Axis* of the turning Pillar. The Reſt is kept up to them, with a proper Degree of Force, by two Screws, W W, which run in two Plugs, X X, faſtened on the Sides of the upright Board, and bear againſt the under Sides of two Pieces fix'd on the Inſide of the Reſt.

The Motion of the Tube is governed by two Braſs Pegs, Y and Z. The firſt of theſe, Y, is plac'd about 10 or 11 Inches from the End of the Arm, and has a Line wound round it, which paſſing under a ſmall Pulley, *f*, fix'd in a vertical Poſition near the End of the Arm, is faſtened to a Staple on the under ſide of the Tube *g*. This Line, by the turning of the Peg, brings the fore End of the Tube to its due Elevation, being acted againſt by the Exceſs of Weight in the hinder End

of the Tube, when the Metal is in it, which is equivalent to about two Pound at *g*, where the Line is faſtened. In great Elevations of the Object above the Horizon, the Line is not carried ſo far as the Point *g*; but is faſten'd a little above the Pulley, to a light ſquare Stick, *b*, having at one End a Hook, by which it takes hold of the Staple *g*. This is done, that the Springyneſs of the Line may not continue a vibrating Motion in the Tube, (when any thing happens to ſhake the Inſtrument) and make the Object appear to tremble. The lower Part of the Stick reſts againſt the end of the Arm, and by its ſlight Friction contributes to the ſame Effect.

The other Peg, *z*, is ſo plac'd, that it may be conveniently reached by one Hand of the Obſerver, while the other is employed about the Peg Y: It regulates the Horizontal Motion of the Tube, by means of a Line, which being wound about the Peg at one End, paſſes by another ſmall Pulley placed cloſe by the Side of the aforementioned one in an Horizontal Poſture (not to be ſeen in the Figure) and is hung on a Pin driven into the little Head K. It is acted againſt by two Springs, *m* and *n* *Fig.* 3. placed in the Box, III, one on each Side of the turning Pillar; that on the right Hand, *m*, draws the right Side of the Pillar forward, by a very ſtrong Line, which being faſtened to the Head of the Spring, paſſes round the back Part of the Pillar to a Pin, at P, by which it is ſtrain'd to its due Strength. The Spring on the Left Hand *n*, draws the Left Side of the Pillar backwards in the ſame manner. Theſe Pins are plac'd on the Pillar a little higher than the Tops of the Springs, that being drawn a little downwards, as well as turn'd round its *Axis*, the Pivot in its Bottom may not be raiſed out of the Hole in the Braſs Plate, when the Reſt bears hard againſt the Rollers at the End of the Arm. Each of theſe Springs draws with a Force equal to about

18 or 20 Pounds Weight, when the End of the Arm is carried close to the small Head *k*, Fig. 1. and consequently (the Semidiameter of the Pillar being an Inch and Half, and the Distance of that Head from the *Axis* about 28 or 29 Inches) the End of the Arm will be carried by the united Forces of both the Springs, towards the other End of the Rest, with a Force equivalent to the Weight of about two Pounds. Each of the Pegs, Y and Z, turns in a Hole made in a Piece of Wood *l*, fastned to the under Side of the Arm; and the Pieces being slit with a Saw from one End through the Hole, and about half an Inch beyond it, the separated Parts are drawn together by a Skrew *m*, till the End of the Peg is griped between them, with a due Degree of Force. By these Pegs, with the help of the Telescope H, the Tube is easily directed to any Object, and made to accompany a Celestial one in its Diurnal Motion, while the End of the Arm moves the whole Length of the rest.

If it be desired, that when the Object is found, the turning of one Peg should carry the Tube along with the Motion of the Heavens, so as to keep the Object always in sight; this may easily be effected in various Manners.

The concave Surface of the Object-Metal has many little Spots in it, which could not be brought to take a Polish. In one, or two Places, the Metal itself seems to have some small Parts, something harder or softer than the rest, occasioning an irregularity in the Figure of the Metal about them. But these Parts being small, in Proportion to the whole, do not seem considerably to affect the Distinctness of the Appearance.

The open Air has commonly an undulating Motion in its Parts, especially in the day time, which occasions the Rays of Light to deflect a little from the strait Lines, in which they ought to move, in order to render the

Species perfectly distinct. The Effect of this, though insensible to the naked Eye, or even through a small Telescope, becomes considerable, when the Object is very much magnified. The Instrument, when try'd at an Object enclosed, so as to secure it from this Inconvenience, seems to bear an Aperture of five Inches and an half, with the deepest of the forementioned Eye-Glasses, as well as the common Telescopes do the usual Charge and Aperture given to them, except that in these the Objects appear a little brighter.

Fig. 1. Represents the Instrument placed on the Machine, in order to be apply'd to Use.

Fig. 2. Represents the Inside of the Slider, with the rest of the *Apparatus* belonging to the oval Plane and Eye-Glass.

Fig. 3. Represents the hinder Part of the Machine, the Back, and one side of the Box, being taken away, to shew the turning Pillar and Springs on the Inside.

Fig. 4. Represents *Saturn*, as it appear'd in *June*, 1720, by this Telescope.

IX. *Anatomia*

IX. *Anatomia ſenis decrepiti, annorum* 109. *facta* Tiguri, *die* 2. Feb. 1723. *A* Joh. Jacobo Scheuchzero, *Tigurino, Med. Doct. Matheſeos Prof. & Regiæ Societatis Socio.*

SUOS habent characteres varii ætatis gradus. A fluiditate aſcendit homo ſenſim per ſoliditatis varias mutationes, donec cum rigiditate & fibrarum veluti immobilitate amittat vitam. Nec contemnendi eſt usûs hæc in medicinâ conſideratio.

Accidit ante menſes aliquot, ut ob decrepitam ſuam ætatem & raram, in Noſocomium fuerit receptus *Johannes Leonhardus Vopper*, Rhætus, Sharanienſis ex cœtu Glantino Fœderis ſuperioris. Is juxta tenorem teſtimoniorum lucem primum vidit, 1. *Maij* 1614. A. 1634. Metalli foſſor in venâ ſepultus, per horas 33. ſub terrâ jacuit: Mortuo, quam vivo, ſimilior inde protractus, propter Abdominis validam, quam paſſus eſt, preſſionem, inde ab illo tempore incontinentiâ urinæ laboraverat. A. 1637. iter fecerat per *Hungariam*, *Turciam*, *Terram Sanctam*, reverſus *Venetias*. Poſt A. 1639. militem egit ſup Capitaneo *Caſparo de Monte*, in ſervitiis *Caroli* Ducis *Lotharingiæ*, in ſtatu *Mediolanenſi*, & A. 1663. in *Luſitaniâ*, ſub Colonello *F. Planta*. A. 1682. interfuit obſidioni *Viennenſi*, & in ultimo bello obſidioni *Landaviæ* & Cladi *Hockſtettenſi*. Ita vitam, per varios caſus & mille rerum diſcrimina, protraxit ſenex noſter ad annos 109. menſes 3.

In cadavere obſervavimus, curſoriè veluti, (non equidem licuit per temporis anguſtiam ſectioni diu immorari) ſequentia.

In

In abdominis cavo erat, parvâ quidem copiâ, ſerum ſanguinolentum extravaſatum.

Inteſtina tenuia fuere omnia inflammata, rubro colore tincta, & Duodenum præ primis integrum admodum dilatatum, internâ ſui parte fracidum prorſus & gangrænoſum; Omentum prorſus emaciatum, ut vix agnoſci potuerit: Pancreas contractum: Hepar ſanum: Veſicula fellis bile repleta: Ductus Choledochi eâdem turgidi, & tota vicinia Inteſtinorum & Meſenterii virore infecta, ut alicubi extravaſata videretur bilis, cujus egreſſum in Duodenum invenire haud potuimus. Prope Pylorum, in Ventriculi ſuperiore parte, aderat expanſio veluti flatulenta, nuce juglande major. Renes ſani, ut & Lien, cujus exterior membrana, jucundo admodum ſpectaculo, obſeſſa erat hinc inde maculis nivei candoris, magis minuſque latis, quæ primo intuitu referebant puſtulas Variolarum maturas, ſed cartilagineæ prorſus erant duritiei, & ultra ſuperficiem reliquæ membranæ aliquantum elevatæ. Obſervo heic, antequam progrediar ulterius, non duntaxat rigeſcere fibras, & contrahi ſupremâ ætate, ſed tantum non inſenſiles fieri; nemo quippe juvenilis vel conſiſtentis ætatis pateretur inflammationem Inteſtinorum, qualis hæc fuit, abſque acutiſſimo dolore, de quo tamen æger poſt ſenile delirium, quod aliquamdiu eſt perpeſſus, ad ſe ultimis vitæ diebus rediens, nihil eſt conqueſtus. Cartilaginea illa Lienis cruſta manifeſto eſt indicio, poſſe ita rigeſcere membranas, ut tandem indurentur.

Thoracis apertio non parum faceſſebat laboris. Fuerunt quippe non ſolum Sterni illæ coſtoſæ prominentiæ, aliàs cartilagineæ, heic planè oſſeæ, ſed & cum ipſis Coſtis tantum non continuæ, indicio manifeſto, Cartilagines fieri ſucceſſu temporis oſſeas, quemadmodum membranæ & arteriæ fiunt cartilagineæ, & ex cartilagineis non ſemel oſſeas narrant Hiſtoriæ. Pulmones viridantibus paſſim

paſſim maculis obſeſſi, in utroque Thoracis latere, poſticâ ſui parte affixi erant Coſtis: Pericardium amplum & multo ſero refertum, cujus & aliqua portio in cavo fluitabat Thorace. Cor ipſum vidimus ſatis amplum, imprimis Auriculas dilatatas præter modum, & tum haſce, tum Ventriculos ſanguine concreto refertos, unde patet ſubſtitiſſe tandem ſanguinis motum, propter defectum contractionis elaſticæ in tubulis arterioſis, & Cordis machinam ſanguini ad concretionem diſpoſito expellendo non amplius fuiſſe ſufficientem, imo propter nimiam reſiſtentiam obrutam. Præſtabat Tendinem illum, quo Cordi inſeruntur arteriæ, vel oſſeum plane, vel cartilagineum ſaltem: Oſſeus ſane, quod novimus, fit in Cervis adultioribus, unde Os de Corde Cervi. Et ſanè aliquid tale offendimus, nimirum Valvulas ſemilunares, præprimis Aortæ, cartilagineas penè, præcipuè mediâ ſui parte. Aortam ipſam deſcendentem obſervavimus valdè amplam, diametri duplo majoris, quam eſt Gula, Pariſini circiter pollicis. Gulæ inſtratæ paſſim erant Glandulæ lentiformes induratæ. Amplitudo illa Aortæ indicat tardiorem ultimis fortè vitæ annis progreſſivum motum ſanguinis, unde arteriæ, quæ propiores ſunt Cordi, fuere ſenſim dilatatæ, ſicuti ſæpe obſervamus dilatari adeo, ubi nimia eſt molis reſiſtentia, ut in Aneuriſma abeat egrediens è Corde Arteria magna.

Pergimus ad Caput, ubi prædura Cranii ſubſtantia rurſum ſolitò majorem poſcebat laborem: Suturæ, imprimis Sagittalis & Lambdoidea, erant fermè obliteratæ, nec prorſus penetrabant utramque Tabulam, ut nulla fuerit per illas è cavitate illâ magnâ Capitis perſpiratio, & ſuccus ille Oſſium nutritius, inter fiſſuras Suturarum extravaſatus, factus quoque fuerit oſſeus. Foramina quidem tria quatuorve ſatis ampla, in ſupremo vertice, ad latas utrumque Sinus Sagittalis, pollicis fermè diſtantiâ ab invicem viſuntur, internam Laminam ad externam uſque

penetrantia,

abſque quod ullum illorum utramque perforet Tabulam. Dura Meninx triplo ferè craſſior fuit, quam eſt ordinariè, coriacea penè: Pia ſeparabatur facile, nimio utpotè irrigata ſero, à Cerebri ſubſtantiâ: Ventriculi omnes ſero erant referti, quod ſat magnâ copiâ quoque fluitabat in Cerebri baſi, imprimis ad Spinalis Medullæ egreſſum. Plexus Choroides Glandulis piſalibus, lymphâ coagulatâ refertis, erat obſeſſus: Septum pellucidum egregiè poterat conſpici: Cæterum Cerebri ipſa ſubſtantia, imprimis interioris, flaccidior ſolito.

Innotuit mihi, inde ex quo obiit decrepitus noſter, retuliſſe eum perſonis fide dignis, quod pater ejus, ſeculum jam ſupergreſſus, tres genuerit liberos, & ex majoribus pauci infra ſeculi ætatem obierint. Hoc certum eſt, noſtro natam filiam *Mariam Magdalenam* ex uxore *Urſulâ Hirzeliâ* de *Naniken* pagi *Tigurini*, quæ S. Baptiſmatis charactere ſignata fuit *Dieſſenhovæ*, 18 Aug. 1707.

FINIS.

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PHILOSOPHICAL TRANSACTIONS.

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I. *Ob-*

I. *A Letter from Dr.* George Mackenzie, *to Sir* Hans Sloane, *Bar. Coll. Med. Lond. Præſ. concerning the* Coati Mondi *of* Braſil.

SIR,

YOU know that the *Coati Mondi* of *Braſil* is ſeldom or never brought alive into *Europe*; yet there were two of them found in Capt. *Green*'s Ship, who was ſome Years ago try'd and condemn'd here for Piracy, one of which being given in Compliment to my Lady *Seaforth*, dy'd in my Cuſtody of a Wound it had received in the Thigh, which I cauſed to be diſſected, and have ſent you the Account of it, compared with that which the *Pariſian* Academiſts publiſh'd of one of them; and which differs from theirs in ſeveral Particulars, moſt of which, as I believe, may proceed from the Difference of Sex, theirs being a Male, and ours a Female.

Theirs was ſix Inches and an half from the end of the Snout to the hinder part of the Head, ours was only four; theirs was ſixteen Inches from the *Occiput* to the Beginning of the Tail, ours was ten; theirs from the Inſertion of the Tail to the End was thirteen Inches, ours twelve; theirs from the Top of the Back to the Extremity of the fore Feet was ten Inches, ours was ſeven; theirs from the Top of the Back to the Extremity of the hinder feet was twelve Inches, ours eight; the Snout of theirs was very long and moveable, like

that of a Hog, but ſtreighter and longer in Proportion, but ours was only two Inches; the four Paws had each five Toes, the Claws of which were black, long. and hollow, like thoſe of the Caſtor; the Toes of the Fore-paws were a little longer than thoſe of the Hind-paws; the Soles without Hair; the Palms and Soles of theſe Fore-paws were covered with a ſoft and tender Skin; the Sole of the hinder Paw was long, having a Heel, at the Extremity of which there were ſeveral Scales a Line broad, and five or ſix long, in all which they perfectly agreed.

The Ears were round, like thoſe of Rats, and covered at the Top with very ſhort Hairs, and in this they likewiſe both agreed, as they did in the Eyes, which were extreamly ſmall and beautiful, but there was ſome Difference in the Hair; for theirs was ſhort, rough and knotty, blackiſh on the Back and Head; and the reſt of the Body mixt with black and red; but in ours the Hair was long, in Proportion to the Animal, eſpecially on the Tail, and the whole was beautified with white and black Circles, which made it have a moſt lovely Aſpect: But from the Snout down all the Throat and Belly to the top of the Tail and the inſide of the Legs, was of a reddiſh Colour. The Tongue of both theirs and ours was chopt with ſeveral Fiſſures or Strokes, which made it rough to the Touch. The *Inciſores* were ſix in each Jaw: The *Canini* were very large, eſpecially thoſe of the lower Jaw; but they did not turn up like Tuſks as theirs did; their Figure was not round, blunt, or white, like thoſe of a Dog, Wolf, or Lyon, but ſharp, by the means of three Angles, which at the Extremity form'd a Point ſharp like an Awl: As to their Colour, they were greyiſh and ſomewhat tranſparent: The *Gula*

was

was large, and cleft like a Hog's; and the lower Jaw, as in a Hog, very much ſhorter than the upper.

We ſhall now proceed to the internal Parts. By the Diſſection we found in ours, as the *Pariſian* Academiſts did in theirs, that under the Skin, and between the Muſcles, there was a great deal of Fat, white and hard, like Tallow. Theirs being a Male had a *Penis* provided with a Bone, whoſe Length did in proportion exceedingly ſurpaſs that of the Bones which are found in the *Penis* of other Animals; ſo we in ours, being a Female, obſerved, that it had an exceeding large *Matrix*, and that the Inſertion of the *Urethra* was upon the right Side of the *Vagina*. The *Epiploon* in ours, as in theirs, was very ſmall; it had little Fat, and was a Complication of Fibres and Fillets, rather than a Membrane; it was not laid upon the Inteſtines, but touched upon the Ventricle. In theirs they obſerved a very large Spleen, but in ours we could diſcern none. We did not obſerve more than they any Veſſels in the external Membrane of the Ventricle, but the *Coronaria Stomachica*, which appear'd as in theirs towards the upper Orifice, and ſoon diſappear'd, ſhooting forth a few Branches. The Liver in ours, like theirs, was ſomewhat blackiſh, and of a Subſtance very homogeneous, without any Appearance of Glands: It had ſeven Lobes, two great ones on the left Side, and five other ſmall ones on the right Side. The *Pancreas* in ours, as in theirs, was faſtened along the *Duodenum*, inclining more towards the right Kidney than the left; but whereas it was very ſmall in theirs, it was very large in ours. The *Meſentery* in ours, as in theirs, was filled with a very hard Fat, which incloſed and almoſt concealed all its Veſſels. The *Inteſtines* in theirs were ſeven Foot long, and all of one Thickneſs, having

nothing to diſtinguiſh them; but in ours they were only 42 Inches and a half. Theirs had no *Cæcum*, but we found it in ours at the upper end of the *Rectum*. The Bladder was very large; the right Kidney in ours, as in theirs, was a great deal higher than the left, and covered with the Lobes of the Liver. The Lungs in theirs had five Lobes, two on the right Side and two on the left, and the fifth in the *Mediaſtinum*, which was as thin as a Spider's Web; but in ours there was ſeven Lobes, three on the right and three on the left, and the ſeventh in the Middle. The *Heart* in ours, as in theirs, reſembled that of a Dog, having the right Auricle extreamly great, and as they found a great deal of ſlimy Matter hardened in the right Ventricle, ſo we found in ours a *Polypus*. The *Muſculus Crotophites* paſſing under the *Zygoma* was in ours, as in theirs, faſtened there, being extraordinary fleſhy even to its Inſertion, made by a very large Tendon, which was incloſed between two Pieces of Fleſh, much thicker than thoſe which are generally found in this Place, and which are thought to be put there to defend and ſtrengthen the Tendon of the Muſcle of the Temples.

The Tendons in the Articulations of the fore Feet were very big and ſtrong. In ours we obſerved two Glands on each Side of the *Anus*, with a Paſſage to each of them, full of a greyiſh fœtid Matter. The *Orbita* in ours, like theirs, was not bony throughout, but it was ſupply'd in the upper Part by a cartilaginous Ligament, which joined the *Apophyſis* of the *Os Frontis* to that of the firſt Bone in the upper Jaw. The Bone, which ſeparates the *Cerebrum* from the *Cerebellum*, was as in Dogs. The *Dura Mater* in ours did not adhere to the *Cranium*, as in theirs. The *Sinus's* of

the

the *Os Frontis* in ours, as in theirs, were full of Matter, like a friable Fat. The *Mammillares Proceſſus*, in ours, as in theirs, were very large. In the Eye both of them agreed exactly, the Globe not exceeding four Lines and a half in Diameter, the Aperture of the Lids being much larger, and the *Pupilla* being as large as the whole Globe of the Eye; the Cryſtalline contained three Lines in Breadth, and two and an half in Thickneſs, and was more convex inwards than outwards; this Thickneſs of the Cryſtalline made the two other Humours to be leſs in Quantity. The *Choroides* was all over of the ſame Colour, *viz.* of a very brown red, without any *Tapetum*, which is hardly ever wanting in the Eyes of other Animals.

Theſe are all the remarkable Differences, that we could diſcover, betwixt ours and that of the *Pariſian* Academiſts; only I muſt inform you of ſome Things, as to the Manner of its Living and Diet, which they had not the Occaſion to obſerve in theirs.

I believe they are miſinform'd in ſaying, that they carry their Tails erected, at leaſt the Tail of this was always trailing on the Ground; neither can I be induced to believe that they eat their Tails, for there was no Part of her that ſhe could endure leſs to be handled than her Tail, the leaſt touching of which would make her cry, or rather hiſs like a Snake; ſhe could endure no manner of Cold; for in the Intervals betwixt the Times of eating, ſhe was either beneath the Bed-cloaths, or on a Cuſhion before a Fire, with the Heat of which ſhe ſeemed to be extreamly well pleaſed.

Her ordinary Meat was butter'd Eggs, Milk and Bread, all manner of roaſted Fleſh, but no Fiſh: I once try'd her with a new kill'd Partridge, which ſhe

eat

eat of moſt voraciouſly, and, for ſeveral Days after, ſhe was very wild and ungovernable, which made me never afterwards try her with raw Fleſh. I am apt likewiſe to believe, their ordinary Dens or Habitations are under Ground in ſandy Banks, like our Rabbits; for when ſhe was brought to the Fields, ſhe would dig up the Sands with her Paws, with an incredible Swiftneſs, ſo that had ſhe not been chain'd, there had been no Poſſibility of recovering her.

GEORGE MACKENZIE.

II. *Imber Calculorum inter aquarum* Pyrmontanarum *uſum, in Viro, nunquam antehac calculum experto, ac alias perfecte ſano, ſubſequente poſtea mictu cruento, tandemque veſicæ ulcere. Communicante Viro Clariſſimo* Abrahamo Vatero, *M. D. Anat. & Botan. Prof.* Wittemb. *R. S. S.*

NObilis Pomeranus, ſanus ac vegetus, uti ipſe de ſe refert, nulliuſque mali ſibi conſcius, ante hos tres annos, ſuaſu amici, converſationis cauſa, ſocium ſe ipſi adjunxit, in bibendis aquis medicatis *Pyrmontanis.* Factum autem eſt, ut, cum potando aliquot dies tranſegiſſet, calculos quoſdam minores, abſque ullo quidem dolore, excludi inter mingendum ſentiret. Effectum hunc criticum eſſe ſibi perſuadens noſter, aquas iſtas aucta doſi bibere incipit, quo facto, quatuor vel quinque

quie dierum ſpatio, ultra quadraginta calculi, rurſus tamen ſine moleſtia, exierunt. Hoc viſo, ſtrenuè & alacriter potare continuat, optimum hujus curæ effectum ſibi promittens. Aſſumpta vero ita nimia aquæ quantitate, urinâ ſupprimitur, adeo, ut ne minimam ejus portionem per tres dies emittere potuerit, uſque dum catheteris ope via aperiretur. Commonefactus itaque à Medicis, ab uſu aquarum ulteriori abſtinuit, remita peractam eſſe credens. Non ita multo poſt, vir iſte iter faciens, continuo mingendi conatu laceſſitur, ac iterum iterumque ex rheda deſcendere cogitur, tandemque inter graviſſimos dolores ſanguinem purum effundit. Duravit mictus cruentus & doloroſus, quamdiu æger in itinere conſtitutus fuit, poſtquam vero hic, domum reverſus, quieti ſtuduit, ſtatim ceſſavit, nec quicquam doloris remanſit. Quoties vero ab illo tempore ſive rheda, ſive equo veheretur noſter, rediit dolor, & ſanguis cum urina ſeceſſit, ſed quiete reſtituta, iterum evanuit, nullo planè dolore ſuperſtitè. Contigit quidem interdum, ut calculus unus vel alter prodiret, rarius tamen hoc factum eſt, nec ullum ex eo dolorem percepit æger, quoniam hi longè minores, quam quos inter aquarum uſum reddidit, fuerunt. Symptomate hoc admodum moleſto per duos integros annos vexatur æger, tandem uſu medicamentorum liberatus eſt. Ceſſante itaque penitus mictu cruento, nil magis timuit, ſed integræ ſanitati reſtitutus ſibi viſus, medicamentis valedixit. At, quid fit? Augetur poſt illud tempus indies Stranguria, virque continuo die nocteque ad urinam reddendam ſtimulatur, quo malo ipſe ad hunc uſque diem affligitur. Urina, quæ parciſſima quantitate, ſummoque cum dolore emittitur, craſſa exit, ob pituitam viſcidam admiſtam, quæ fundum ſtatim petit, glutini ex farina confecto ſimilis, tantæ tenacitatis, ut in fila

quaſi

quaſi trahi queat. Æger interea appetitu bono gaudet, & ſomno quoque ſufficienti utitur, nec ullibi præterea in corpore dolorem ſentit.

Conſideratio Caſus, ejuſque circumſtantiarum ſingularum.

Si quis hiſtoriam morbi, quoad omnes ejus conditiones, accuratè perpendat, mecum conſitebitur, eandem vix parem inter obſervationes Medicas agnoſcere. Notatu digniſſimum imprimis eſt, potu aquarum iſtarum mineralium, calculos ſat inſignes, in tanta copia, atque intra tam breve temporis ſpatium excluſos eſſe, a viro, uti ipſe de ſe refert, ante aquarum uſum perfectè ſano, nec ullum calculi indicium unquam ſentiente. Non levem hoc in animo excitare poteſt ſuſpicionem, calculos non tam ab aquis propulſos, quam ex croco minerali, qualem aquæ tales medicatæ in ſinu gerunt, generatos potius in hoc ægro fuiſſe. Parum quidem huic ſententiæ favere videtur tempus admodum breve tot calculorum concretioni vix idoneum, quoniam hi, paucos poſt dies ab inchoato aquarum potu, excluſi ſunt. Non tamen exiſtimo, quenquam facilè definire poſſe, quantum temporis ſpatium ad calculi in corpore generationem requiratur; poterit hoc forte eſſe exiguum. Longè enim minus veritati conſentaneum videtur, calculos iſtos jam tum in viis urinariis latitaſſe, quoniam vir ille nunquam antehac urinæ difficultatem, aut aliud calculi ſignum percepit. Confirmant e contrario omnes hujus caſus circumſtantiæ, *concretionem iſtam ſubito factam eſſe.* Calculi enim ipſi nullatenus aſperi atque anguloſi, quales alias veſicæ calculi eſſe ſolent, ob ſucceſſivam ſpiculorum ſalinorum cohæſionem, ſed piſorum majorum minorumque inſtar, rotundi, glabri, & politi obſervantur, quod coagulationem eorum ſubitaneam

bitaneam docere videtur. Color eorum luteus convenit exactè cum ſedimento illo, coctione ex aquis *Pyrmontanis* extracto, cujus minimam portionem ex quatuor unciis aquæ hujus paratam addere volui, ut tanto melius convenientia iſtâ pateſcat. Fracti calculi ſtrata ejuſmodi variegata interius monſtrant, qualia in tophis thermarum Carolinarum deprehenduntur, quorum pariter particulam exiguam adjeci. Addidi propterea quoque calculos duos, cum aliquot fruſtulis contritorum, pauciſſimos enim tantum obtinui. Ultimo tandem loco attendi quoque meretur ſingularis iſta circumſtantia, quod maxima horum calculorum pars inter ipſum aquarum uſum excluſa ſit, poſt illud tempus vero rariſſimè tales, iique longe minores prodierint. Non tamen ideo culpa hujus rei in aquas iſtas medicatas conjicienda erit, quaſi hæ ad calculi generationem diſponant, cum potius debilitati viſcerum, ac pravæ digeſtioni adſcribi debeat effectus ille extraordinarius. Nolo etiam leviſſimas has meditationes atque conjecturas pro veritate indubitata venditare, rem totam potius Illuſtriſſimæ Societati Regali decidendam, ea, qua erga ipſam ſum, pietate ac obſervantia trado.

Dabam Wittembergæ Saxonum,
d. vi. Jan. M DCC XXIII.

III. *Obſervations upon diſſecting the Body of a Perſon troubled with the Stone. By Dr.* Perrot Williams, *Phyſician at* Haverford-Weſt *in* South-Wales.

MR. *William Bowen* of the Town and County of *Haverford-Weſt*, aged between 40 and 50, having been, for about the Space of ſeven Years, ſeverely afflicted with the uſual Symptoms of the Stone in the Kidneys and Bladder, *viz.* Bloody Urine after Exerciſe, Strangury, *&c.* Dy'd in *May* 1722. His Body being opened, there were found in the Bladder ſix ſmooth oval Stones, exactly of the ſame Figure, and nearly of the ſame Magnitude: There were alſo three Cells in each Kidney, the Figure of each ſuitable to that of the Stones: The *Ureters* were ſo preternaturally extended, as very eaſily to admit the largeſt of the Stones to paſs from the Kidney to the Bladder. The *Viſcera, &c.* appear'd in their natural State.

IV. *Hiſtoria Sectionis Viri ex Renum Calculo defuncti. Ex Epiſtolâ Viri Doctiſſimi* P. Hardiſway, *M. D. ad* Gulielmum Stukeley, *M. D. Coll. Med.* Lond. *& Reg. Soc. Soc.*

HOmo ſeptuaginta circiter annos natus, ventris dolore horrendo correptus eſt die Octobris 19° An. 1722. Acceſſerunt Vomitus & Urinæ difficultas, præ doloris atrociâ ſeſe erigere non poterat, ſed miſere incurvatus, dies noctesque prope focum jacebat ejulans. Sexto morbi die, urinâ prorſus ſuppreſsâ, de dolorosâ circa Hypochondria ſtricturâ, perinde ac a funibus circumjectis, querebatur, poſtea de pondere quodam in veſicâ moleſto, quaſi Rapi majoris, (ſic aiebat) inibi hoſpitantis. Omnibus in pejus ruentibus, die morbi duodecimo ad plures abiit. Cadavere aperto veſicam ſecuimus, quam ab ullis vel minimis calculi veſtigiis immunem invenimus; in utroque autem rene (multâ aquâ refertis) repertus eſt calculus, (*Fig.* 1, 2.) inſignis, ſcaber & multiplici ramo per parenchyma ſe diſpergens, quem integrum extrahere nullâ arte potuiſſes, niſi totâ prius fruſtulatim decerptâ carne. Ramorum maximus in ureteris caput ſe inſinuans, perbelle adeo id occupaverat, ut ampulla obturamento ſuo arctius occludi vix poſſet. Ulterius ſcrutari nobis non licuit, ideo unum tantum addam, nempe, quod Omentum inſtar faſciæ anguſtioris ſub hepate retractum deliteſcebat. Pauper erat & corpore athletico, ſemper ſanus, niſi quod a paucis annis, aliquando ſabuloſa per urinas excerneret.

V. *An Account of the Depth of Rain fallen from* April 1, 1722, *to* April 1, 1723. *Obſerved at* Widdrington *in* Northumberland, *and communicated to the Publiſher by the Reverend Mr.* Horsley.

I Have kept an exact Account of what Rain has fallen the laſt Year in this Place, which I have here ſent you. The weighing the Water and reducing it from Weight to Depth ſeem'd pretty troubleſome, even when done in the eaſieſt Method: To remedy this Inconvenience (beſides a Funnel and proper Receptacle for the Rain) I uſe a cylindrical Meaſure and Gage. The Funnel is 30 Inches diameter, and the cylindrical Meaſure exactly 3; the Depth of the Meaſure is 10 Inches, and the Gage of the ſame Length, with each Inch divided into 10 equal Parts; or, inſtead of a Gage, the Inches and Diviſions may be mark'd on the Side of the cylindrical Meaſure. The *Apparatus* is ſimple and plain, and it is eaſy to apprehend the Deſign and Reaſon of the Contrivance; for the Diameter of the cylindrical Meaſure being juſt $\frac{1}{10}$ of that of the Funnel, and the Meaſure exactly 10 Inches deep, 'tis plain that 10 Meaſures of Rain make an Inch in Depth; one Meaſure, $\frac{1}{10}$; one Inch on the Gage, $\frac{1}{100}$; and $\frac{1}{10}$ of an Inch on the Gage, $\frac{1}{1000}$, *&c.* By this Means the Depth of any particular Quantity which falls, may be ſet down with Eaſe and Exactneſs, and the

the whole at the End of each Month, or every Year, may be ſumm'd up without any Trouble.

By the following Account you'll ſee, that ſome of the Summer Months, particularly *May* and *July*, were very wet, and ſome of the Winter ones very dry; ſo that, one with another, this Year's Rain, as far as can well be conjectur'd, may be look'd upon as a *Medium*. And if ſo, it differs not above two or three Inches, from the mean Quantity of Rain which falls at *Upminſter*, *Paris*, and *Liſle*, being leſs than at *Liſle*, and more than at the other two Places.

An Account of the Depth of Rain fallen from April 1, 1722, *to* April 1, 1723.

	Inch.
In *April*	1,015
In *May*	3,532
In *June*	2,570
In *July*	4,350
In *Auguſt*	2,132
In *September*	1,155
In *October*	,600
In *November*	2,205
In *December*	1,780
In *January*	1,225
In *February*	,485
In *March*	,195
In the whole Year	21,244

VI. Pappi Alexandrini *Propoſitiones duæ generales, quibus plura ex* Euclidis *Poriſmatis complexus eſt, Reſtitutæ a Viro Doctiſſimo* Rob. Simſon, *Math. Prof.* Glaſc. *Vid.* Pappi *præfationem ad Lib. 7. Coll. Math.* Apollonii *de Sectione rationis libris duobus a Clariſſ.* Hallejo *præmiſſam* pag. VIII. & XXXIV.

Ἐὰν ὑπὸ δύο εὐθειῶν ἢ παρ' ἑνὸς σημείου ἢ παραλλήλων, &c.

Textus Pappi, qui in hac & ſequente Propoſitione injuria temporis truncatus eſt, hoc modo Reſtituendus videtur.

" [SI duæ rectæ lineæ in duas rectas lineas ſibi mu-
" tuo occurrentes vel inter ſe parallelas ducantur,]
" & dentur in una earum tria [a] puncta [vel duo, ſi re-
" cta in qua ſunt, parallela fuerit alicui ex tribus re-
" liquis] : cætera vero puncta præter unum [b] tangant re-
" ctam poſitione datam, etiam hoc quoque tanget re-
" ctam poſitione datam." Hoc autem de quatuor tantum rectis dicitur, quarum non plures quam duæ per idem punctum tranſeunt. In quolibet vero propoſito rectarum numero ignoratur, quamvis vera ſit, hujuſmodi Propoſitio. " Si quotcunque rectæ occurrant in-
" ter ſe, nec plures quam duæ per idem punctum; data
" vero ſint puncta omnia in earum unâ, unumquodque autem

[a] *Tria puncta*] interſectionum ſc. [b] *Tangant rectam*] i. e. unum punctum tangat unam aliquam rectam poſitione datam, & aliud tangat aliam poſitione datam, &c.

" autem punctum in aliâ tangat rectam positione da-
" tam ; " vel generalius sic. Si quotcunque rectæ occurrant inter se, neque sint plures quam duæ per idem punctum, omnia vero puncta in earum unâ data sint ; reliquorum numerus erit numerus triangularis, cujus latus exhibet numerum punctorum rectam positione datam tangentium ; quarum intersectionum si nullæ tres existant ad angulos trianguli spatii, [nullæ quatuor ad angulos quadrilateri, nullæ quinque, &c. i. e. universim, si nullæ harum intersectionum in orbem redeant] unaquæque intersectio reliqua tanget positione datam. Propositio prima in decem dividitur casus, monente ipso Pappo, quorum ejus, in quo nullæ ex quatuor rectis sunt inter se parallelæ, neque rectæ positione datæ per data puncta transeunt, demonstrationem hic apponemus ; hic enim Casus inter omnes maximè est generalis, ejusque demonstratio secundæ propositionis demonstrationi omnino est necessaria. (*Fig.* 3. *&* 4.) Sint igitur quatuor rectæ A B, A D, B E, C E. Et data sint tria puncta intersectionum A, B, C in earum qualibet, reliquarum vero intersectionum D, E, F, una D tangat rectam G K positione datam, alia E tangat rectam H K positione datam ; tanget etiam reliqua F rectam positione datam. Ducatur per F recta M F parallela ad A B, quæ occurrat ipsis H K, K G, C E, in M, N, O. Quoniam igitur data est ratio H B ad B C dabitur eidem æqualis ratio M F ad F O, & quoniam datur ratio A C ad A G, dabitur eidem æqualis ratio F O ad F N ; quare datur ratio M F ad F N, igitur si jungatur F K, quæ occurrat ipsi A B in L, dabitur ratio H L ad L G ; & datur H G positione & magnitudine ; quare punctum L datur, & datum est punctum K, igitur K L positione datur.

Sit igitur H L ad L G in ratione composita ex rationibus H B ad B C & A C ad A G, & jungatur K L,

erit

erit hæc recta quam tangit punctum F, hoc eſt, ſi ducatur quævis CE, poſitione datis occurrens in D, E, & jungantur AD, BE ſibi mutuo occurrentes in F; recta erit linea quæ per K, F, L tranſit. Nam per F ducatur MF parallela ipſi AB, & quoniam ratio MF ad FN compoſita eſt ex rationibus MF ad FO & FO ad FN, hoc eſt, ex rationibus HB ad BC & AC ad AG, ex quibus etiam componitur ratio HL ad LG; erit HL ad LG ut MF ad FN, & igitur HG ad MN, hoc eſt, HK ad MK ut HL ad MF: Quare recta eſt linea quæ per K, F, L tranſit, per 14. 1 aut 32. 6 Elem.

Explicatio Secundæ Propoſitionis.

Obſervandum hic eſt, Numerum interſectionum, quæ in una recta reperiuntur in quâcunque propoſita multitudine rectarum, quarum non plures quam duæ per idem punctum tranſeunt, & quarum nullæ ſunt inter ſe parallelæ, unitate minorem eſſe ipſo numero rectarum: Nam duæ in unico puncto ſe invicem ſecant, tertia vero ducta priores in duobus, quarta priores in tribus punctis ſecat, &c. Et igitur numerus interſectionum in tribus rectis eſt unitas binario aucta, i. e. ternarius; numerus eorundem in quatuor rectis eſt ternarius ternario auctus; in quinque vero rectis eſt ultimus præcedens ſeu ſenarius quaternario auctus, &c. in infinitum; Qui numeri, ut manifeſtum eſt, triangulares ſunt, quorum cujuſque latus eſt numerus interſectionum, quæ inveniuntur in unâ qualibet recta, i. e. numerus qui unitate minor eſt numero omnium rectarum. Igitur ſi ex hoc numero omnium interſectionum dematur numerus omnium punctorum datorum, qui idem eſt cum numero interſectionum in una quâvis recta; reliquus erit adhuc triangularis, cujus la-

tus ſc. unitate deficit a latere prioris, quod exhibet numerum omnium punctorum, & proinde binario minus eſt numero rectarum propoſitarum. Et hic eſt numerus interſectionum quas tangere rectam poſitione datam *Pappus* in hac Propoſitione requirit, quarumque ſi nullæ tres ſint ad angulos trianguli; [nullæ quatuor ad angulos [c] quadrilateri & ita deinceps;] unamquamque interſectionem reliquam tangere rectam poſitione datam affirmat. Quæ autem uncis incluſa ſunt, textui neceſſitate coacti adjecimus, nam ſine iis propoſitio vera non eſſet extra caſum quinque rectarum.

Commode vero in duos caſus dividitur propoſitio; quos etiam aperte ſatis indicat *Pappus*, qui Hypotheſin caſus facilioris propoſitioni, hujus generis univerſaliſſimæ ſimul & elegantiſſimæ præmittit.

CASUS PRIMUS.

Si quotcunque rectæ occurrant inter ſe nec plures quam duæ per idem punctum; data vero ſint puncta omnia in earum unâ, unumquodcunque autem punctum in alia tangat rectam poſitione datam; unaquæque interſectio reliqua tanget rectam poſitione datam. Sint enim quotcunque rectæ, (*Fig.* 5.) *ex. gr.* ſex A F, B G, C H, D K, E L, E A; & data ſint omnia puncta in earum unâ, ſc. A, B, C, D, E; omnia vero puncta in aliâ ſc. F, L, M, N, tangant rectam poſitione datam: unaquæque reliqua interſectio tanget poſitione datam.

Sumatur enim quævis ex reliquis *ex. gr.* O, & quoniam quatuor ſunt rectæ O L, O N, A N, A B, & data ſunt tria puncta in unâ earum ſc. A, B, E, reliqua vero

[c] Intelliguntur etiam hic figuræ quarum latera ſe mutuo decuſſant Diagonalium inſtar, æque ac cæteræ.

vero præter unum O, viz. ipſa L, N tangunt rectam poſitione datam, tanget etiam O poſitione datam per *Prop.* I. Eodem modo idem de omnibus reliquis oſtendetur.

CASUS SECUNDUS.

Cæteris manentibus jam non ſint omnia puncta rectam poſitione datam tangentia (quorumque numerus binario minor eſt numero rectarum propoſitarum) in eâdem recta, ſed nulla eorum in orbem redeant; oſtendendum eſt reliqua omnia tangere rectam poſitione datam.

LEMMA I.

Si quotcunque rectæ inter ſe occurrant neque plures quam duæ per idem punctum, & ſumantur quævis rectarum, ſit vero numerus interſectionum, qui conficitur ſumendo duo puncta in unaquâque rectarum ſumptarum æqualis numero harum rectarum; puncta hæc in orbem redibunt. Nam quoniam ſunt duo puncta in unaquâque recta, erunt ad minimum tria in duabus rectis, & quatuor in tribus & ita deinceps; ſemper ſc. erit numerus punctorum ad minimum unitate major numero rectarum niſi recta ultima tranſeat per punctum primum; i. e. niſi rectæ in orbem redeant, in quo ſolo caſu æqualis erit numerus punctorum numero rectarum.

LEMMA II.

Si quotcunque rectæ inter ſe occurrant neque plures quam duæ per idem punctum, ſumantur vero quælibet ipſarum interſectiones, quarum numerus numero omnium

um rectarum æqualis ſit; vel hæ interſectiones omnes, vel earum aliquæ, in orbem redibunt, ſeu invenientur ad angulos polygoni vel trianguli.

Nam tres interſectiones trium rectarum ſunt ad angulos trianguli; ſi vero ſint quatuor rectæ, & ſumantur quatuor puncta, una harum neceſſario invenietur in unâquaque recta; quod ſi in unâ aliqua ex quatuor rectis unum tantum inveniatur punctum, tria reliqua erunt in tribus reliquis rectis, & igitur ad angulos trianguli: Si vero nulla fuerit recta, in qua unum duntaxat punctum invenitur, erunt duo in unâquaque ex quatuor rectis, & ſunt quatuor puncta, ergo per *Lem.* 1. ſunt ad angulos quadrilateri. Et manifeſtum eſt ſi fuerint quatuor rectæ, & ſumantur plura quam quatuor puncta, multo magis aliqua eorum in orbem redire.

Sint jam quinque rectæ, & ſumantur quinque interſectionum puncta, &, ſi fuerit aliqua ex rectis in qua nullum invenitur punctum ex hiſce quinque, erunt omnia quinque in quatuor reliquis rectis; Si vero fuerit aliqua recta in quâ unum duntaxat invenitur punctum, erunt reliqua quatuor puncta in reliquis quatuor rectis; igitur in utroque caſu puncta aliqua erunt ad angulos trianguli, vel quadrilateri, per præcedentem caſum: Si autem nulla fuerit recta in qua vel nullum vel unicum invenitur punctum, erunt duo in unâquaque ex quinque rectis, & ſunt quinque puncta, ergo per *Lem.* 1. ſunt ad angulos quinquelateri. Eodem prorſus ratiocinio oſtendetur in ſex rectis & ita in infinitum.

In *Fig.* 6. ſunt octo rectæ, & octo ſumuntur puncta, quorum quatuor in orbem redeunt.

Hiſce præmiſſis propoſitio hoc modo demonſtratur. Primo ſint quinque rectæ (*Fig.* 7.) A D, A E, B F, C G, D H, & demptis punctis datis in una rectarum, viz. A, B, C, D,

reliqua erunt ſex puncta E, F, G, H, K, L, in quatuor rectis, & tria horum (nam latus numeri triangularis 6 eſt 3) quæ non ſunt ad angulos trianguli, a tribus ſc. rectarum propoſitarum contenti, *ex. gr.* E, F, G, tangant rectam poſitione datam; oſtendendum eſt reliqua tria K, H, L etiam tangere rectam poſitione datam.

Quoniam igitur ſunt quatuor rectæ A E, B F, C G, D F, & tria interſectionum puncta in ipſis ſumantur, viz. E, F, G; erit una aliqua harum rectarum in quâ neceſſario invenietur unum tantum ex hiſce tribus punctis; nam ſecus erit vel aliqua in qua nullum eſt punctum, & proinde erunt tria puncta in tribus reliquis rectis, i. e. ad angulos trianguli contra Hypotheſin; vel erunt ad minimum duo puncta in unâquaque quatuor rectarum, & igitur quatuor eſſent ad minimum puncta; ſed ſunt tantum tria; quare neceſſe eſt eſſe aliquam rectam in qua unum tantum invenitur punctum: Sit hæc recta A E, in qua ſc. eſt punctum E, ergo reliqua duo F, G, ſunt in reliquis tribus rectis B F, C G, D F; igitur, quoniam dantur tria puncta B, C, D, reliquum punctum L in iſtis tribus rectis, tangit rectam poſitione datam per primam Propoſitionem: Sumatur nunc G E, recta ſc. ex hiſce tribus quæ tranſit per punctum E in quartâ recta, & omnia puncta in hâc recta G E tangent poſitione datam. Quare, per caſum primum hujus propoſitionis, reliqua puncta K, H tangunt rectam poſitione datam.

Sint jam ſex rectæ (*Fig.* 8.) A E, A F, B G, C H, D K, E L; & demptis quinque datis punctis A, B, C, D, E, quæ ſunt in unâ rectarum, reliqua erunt decem puncta F, G, H, K, L, M, N, O, P, Q in quinque rectis; & ex Hypotheſi quatuor horum, quæ non in orbem redeunt, tangunt rectam poſitione datam; ſint hæ, F, G, H, K; & oſtendendum eſt reliqua ſex L, M, N, O, P, Q tangere rectam poſitione datam.

Quoniam

Quoniam igitur ſumuntur quatuor puncta interſectionum F, G, H, K, in quinque rectis A F, B G, C H, D K, E L; erit una aliqua recta in qua unum tantum ex hiſce punctis reperitur; nam ſecus erit vel aliqua in qua nullum eſt punctum, & proinde quatuor puncta erunt in quatuor reliquis rectis, & igitur aliqua eorum in orbem redibunt per *Lem.* 2. contra hypotheſin: vel erunt duo ad minimum puncta in unaquaque quinque rectarum, & ita eſſent quinque ad minimum puncta; ſed ſunt tantum quatuor, quare neceſſe eſt eſſe aliquam rectam in quâ unum tantum invenitur punctum; ſit hæc A F in quâ ſc. eſt punctum F; ergo reliqua tria G, H, K ſunt in reliquis quatuor rectis B G, C H, D K, E L, & dantur puncta B, C, D, E; ergo per primam partem hujus demonſtrationis reliqua tria puncta in his quatuor rectis, ſc. L, P, Q, tangunt rectam poſitione datam. Sumatur nunc B F, recta ſc. ex hiſce quatuor, quæ tranſit per punctum F in quinta recta; & omnia puncta in hac recta B F tangent rectam poſitione datam: Quare per Caſum primum hujus Propoſitionis reliqua puncta M, N, O tangunt rectam poſitione datam. Eodem prorſus modo demonſtrabitur Propoſitio in ſeptem, octo, &c. rectis in infinitum, ut patet.

Quod autem conditio uncis incluſa in hac propoſitione omnino ſit neceſſaria, patet in his duobus exemplis; idem vero univerſaliter præcedentium ope demonſtrari poteſt.

His adjecit Clariſſimus Profeſſor Poriſmata duo ſequentia primi Libri Poriſmatum Euclidis *a ſe quoque reſtituta.*

Poriſma primum, Lib. 1. Poriſmatum *Euclidis*, quod ſervavit *Pappus Alexandrinus* in præfatione ad *Lib.* 7. Math. Coll. *Vid. pag.* XXXV. *Ejuſd. Præf.*

Si a duobus punctis datis inflectantur duæ rectæ ad rectam poſitione datam, abſcindat autem earum una a

recta positione data segmentum dato in eâ puncto adjacens, auferet etiam altera ab aliâ recta segmentum datam habens rationem.

Sint enim duo puncta data D, C, (*Fig. 9.*) a quibus ad positione datam A B inflectantur D B, C B; quarum una D B abscindat a positione data E F segmentum K M adjacens dato puncto M: Ostendendum est alteram C B auferre ab aliâ quadam recta segmentum datam habens rationem ad ipsum K M.

Juncta C D occurrat positione datis A B, E F in A, F punctis, quæ proinde data erunt. A puncto K, in quo inflexa B D occurrit ipsi E F, ducatur K H parallela ad A D, & occurrens alteri inflexæ B C in H, ipsi vero B A in N. Quoniam igitur dantur puncta A, D, C, dabitur ratio A D ad D C, & igitur ratio N K ad K H; quare si jungatur E H occurrens ipsi A D in G, dabitur ratio A F ad F G; sed datur A F, quare & F G datur, & punctum G; & datum est E, quare E G positione & magnitudine datur; & datur E F, quare ratio E F ad E G datur; & ducta M O per datum punctum M parallela ipsi A D, & occurrens E G in O, dabitur M O positione, & ideo punctum O; & propter parallelas M O, F G, K H est M K ad O H, ut E F ad E G, quæ sunt in data ratione. Igitur recta B C aufert a rectâ E G positione data, segmentum O H dato puncto O adjacens, in datâ ratione ad segmentum M K. *Q. E. D.*

Componetur vero ita, fiat A F ad F G ut A D ad D C, & juncta E G, per M ducatur M O parallela ad A D; ostendendum est, si a punctis D, C inflectantur ad A B quævis D B, C B abscindentes ex ipsis E F, E G, segmenta M K, O H punctis M, O adjacentia, fore ipsa in data ratione E F ad E G, seu, quod idem est, esse junctam H K parallelam ipsi A D; hoc vero videtur omissum fuisse ab *Euclide*, utpote quod tribus verbis

verbis indirecte demonſtrari poſſit; *Pappus* autem in *Lem.* 1°. ad Poriſmata, duas directas ejuſdem demonſtrationes affert, quarum ſecundam, quæ paululum eſt corrupta apud *Commandinum*, hic ſubjungemus integritati ſuæ reſtitutam.

Vid. Pap. *Lib.* 7. *fol.* 239. *pag. prior.*

Per Compoſitam vero proportionem hoc pacto.

Quoniam eſt ut A F ad F G ita A D ad D C (*Vid. fig.* Papp. *fol.* 238. *pag. poſt. vel fig. noſtr.* 9.) convertendo erit ut G F ad F A ita C D ad D A, & componendo, permutandoque & convertendo ut A D ad D F ita A C ad C G. Sed proportio A D ad D F compoſita eſt ex proportione A B ad B E, [& E K ad K F, & proportio A C ad C G compoſita eſt ex proportione A B ad B E] & proportione E H ad H G. Proportio igitur compoſita ex A B ad B E & E K ad K F eadem eſt, quæ componitur ex A B ad B E & E H ad H G. communis auferatur ratio A B ad B E, reliqua igitur E K ad K F eadem eſt quæ E H ad H G; quare H K ipſi A G parallela eſt.

Poriſma Secundum. Quod punctum illud tangit rectam poſitione datam. Secundum Poriſma videtur ſequenti modo explicandum eſſe.

Si a duobus punctis datis C, G (*Fig.* 10.) ducantur duæ rectæ C B, G D occurrentes duabus rectis poſitione datis A B, E D, ſitque recta D B puncta interſectionum jungens parallela ipſi C G, quæ per datum punctum ducitur, interſectio K ductarum tanget rectam poſitione datam.

Occurrant enim poſitione datæ ſibi mutuo in H, & juncta K H occurrat C G in F & B D in M. Igitur propter parallelas eſt A E ad E F (ut B D ad D M hoc eſt) ut C G ad G F; & igitur A E ad C G ut E F ad G F, datur itaque ratio E F ad G F, & datur E G, quare pun-

punctum F, & datur punctum H, quare HF positione. Sit itaque ut AE ad EF ita CG ad GF, & juncta HF erit recta quam tangit punctum K; hoc est ducta quævis GD, occurrens ipsi FM in K, erit recta linea quæ per CKB transit, nam est DB ad DM ut AC ad EF, hoc est ex constructione ut CG ad GF, quare DB ad CG ut (DM ad GF hoc est ut) DK ad KG, & igitur est CKB recta linea.

Pappus idem aliter demonstrat in 2do *Lemmate*, quod hoc modo debet legi: sc. Ducatur per G, (*Vid. Fig.* Pap. *fol.* 239. *pag. post. vel Fig. nostr.* 10.) recta linea GL parallela DE, & juncta HK ad L producatur. Quoniam igitur est ut AE ad EF ita CG ad GF, & permutando [AE ad CG ut EF ad GF]; ut autem AE ad CG ita est EH ad GL, [d] quod duæ duabus sunt parallelæ. Ut igitur EF ad FG ita EH ad GL, atque est EH parallela ipsi GL, ergo recta linea est quæ per HKLF transit.

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[d] *Quod duæ duabus sunt parallelæ*, sc. AE ad DB, & GL ad DE, unde est AE ad DB ut EH ad DH, & est DB ad CG (ut DK ad KG, i. e.) ut DH ad LG; ergo per 22. 5. est AE ad CG ut EH ad GL.

VII. *De*

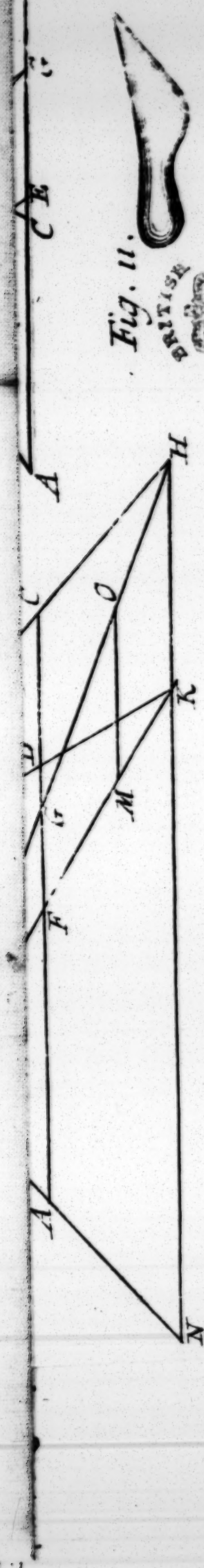


Fig. 11.

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s partem, conficiebant; quod compertum fuerat per Methodum in Actis Philo-
oſoph. expoſitam. No. 355. pag. 761.

Phil: Trans: N° 377.

Calculus Renis sinistri

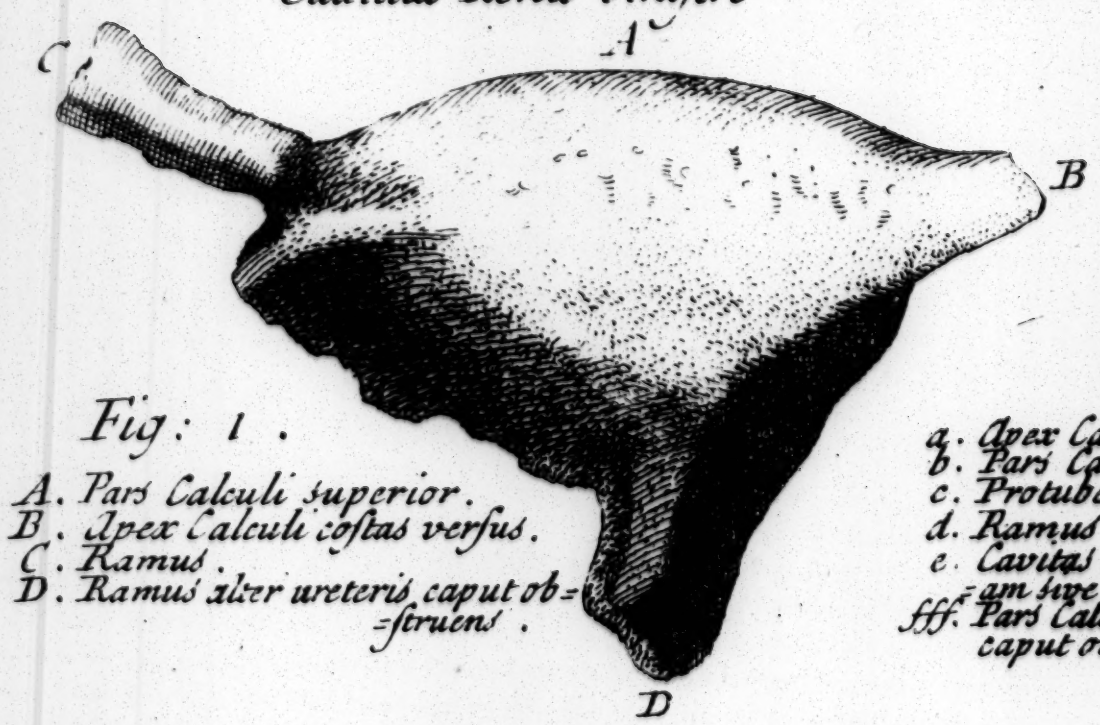


Fig: 1.

A. Pars Calculi superior.
B. Apex Calculi costas versus.
C. Ramus.
D. Ramus alter ureteris caput ob=
=struens.

Calculus Renis dextri

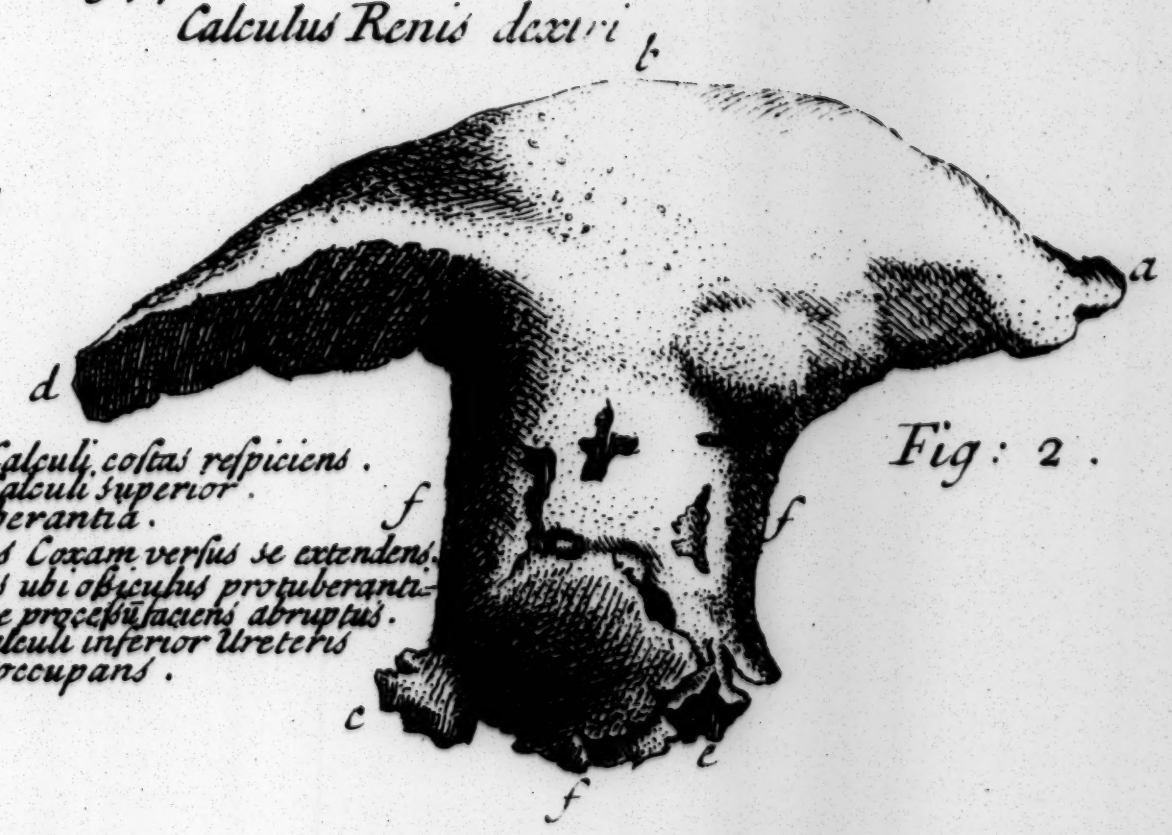


Fig: 2.

a. Apex Calculi costas respiciens.
b. Pars Calculi superior.
c. Protuberantia.
d. Ramus Coxam versus se extendens.
e. Cavitas ubi obsiculus protuberanti=
=am sive processū faciens abruptus.
fff. Pars Calculi inferior Ureteris
caput occupans.

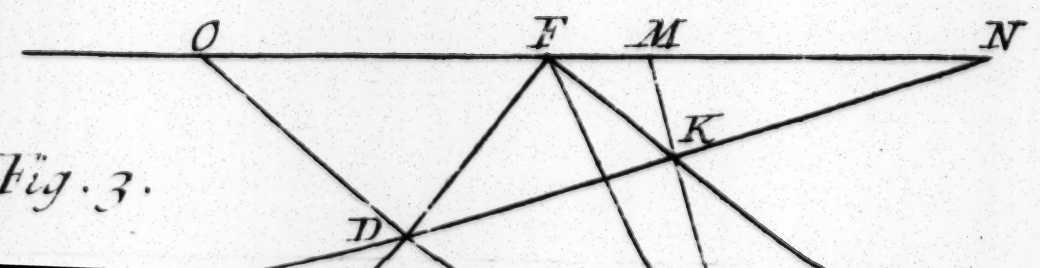


Fig. 3.

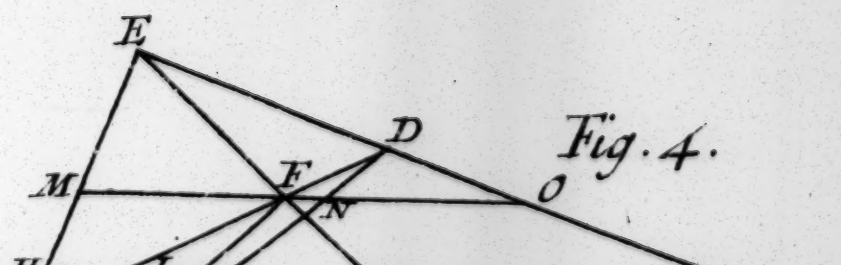


Fig. 4.

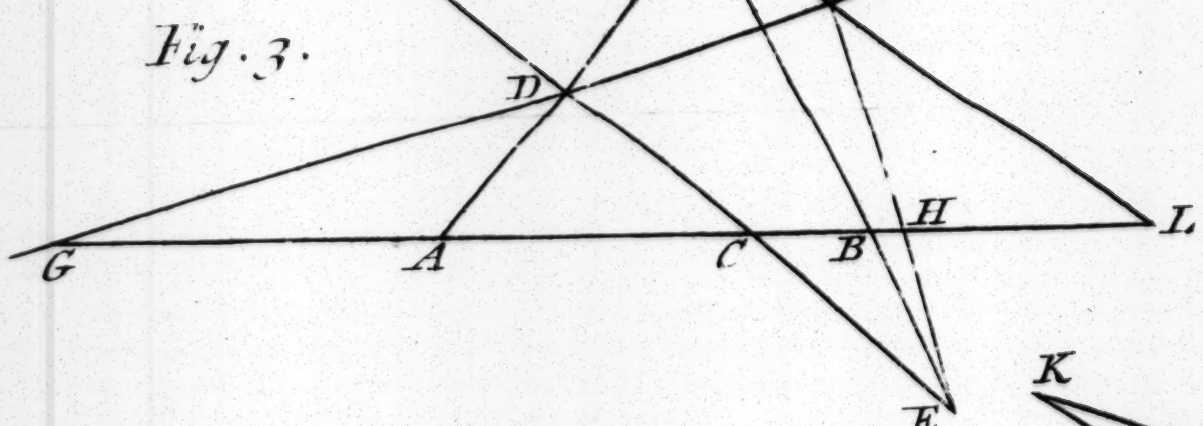
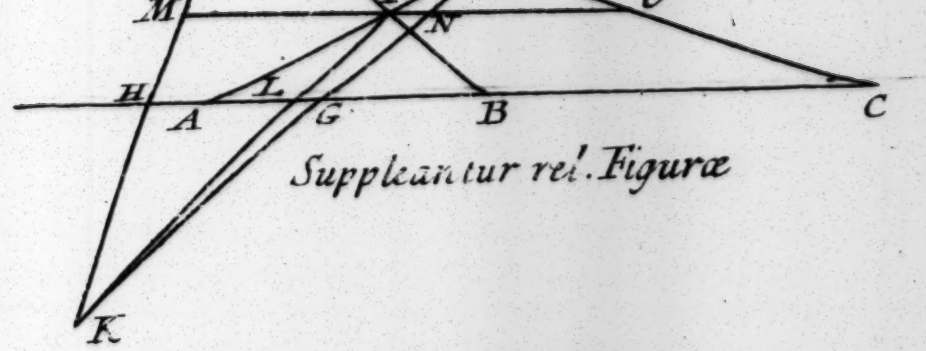


Fig. 3.



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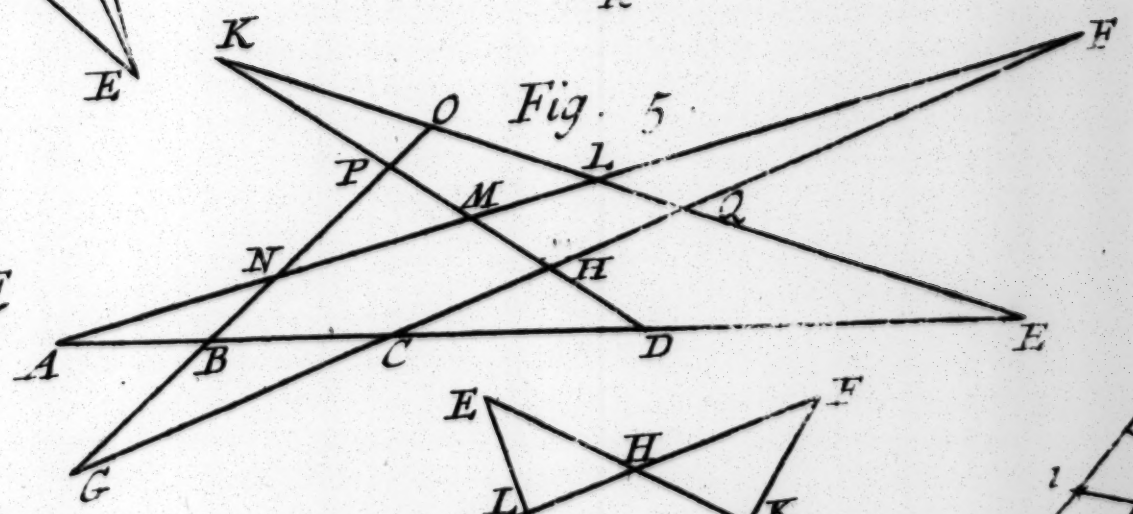
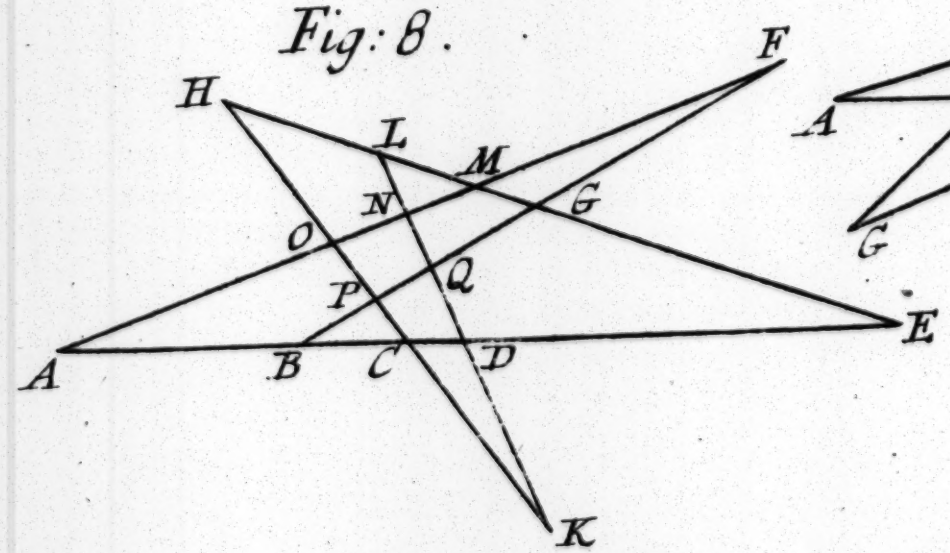


Fig. 5

Fig: 8.



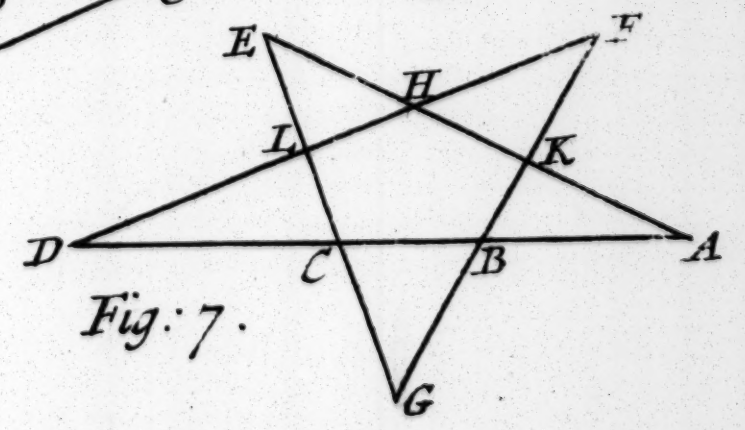


Fig: 7.

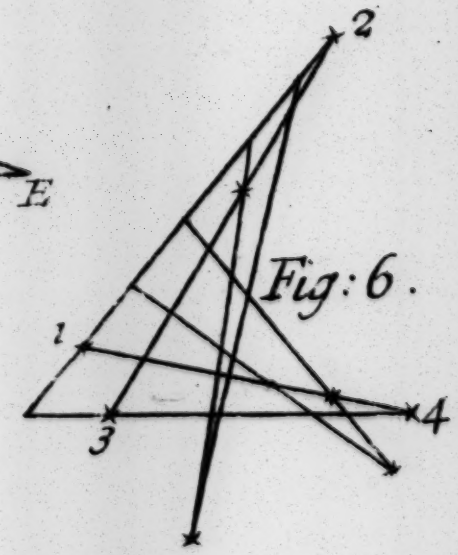


Fig: 6.

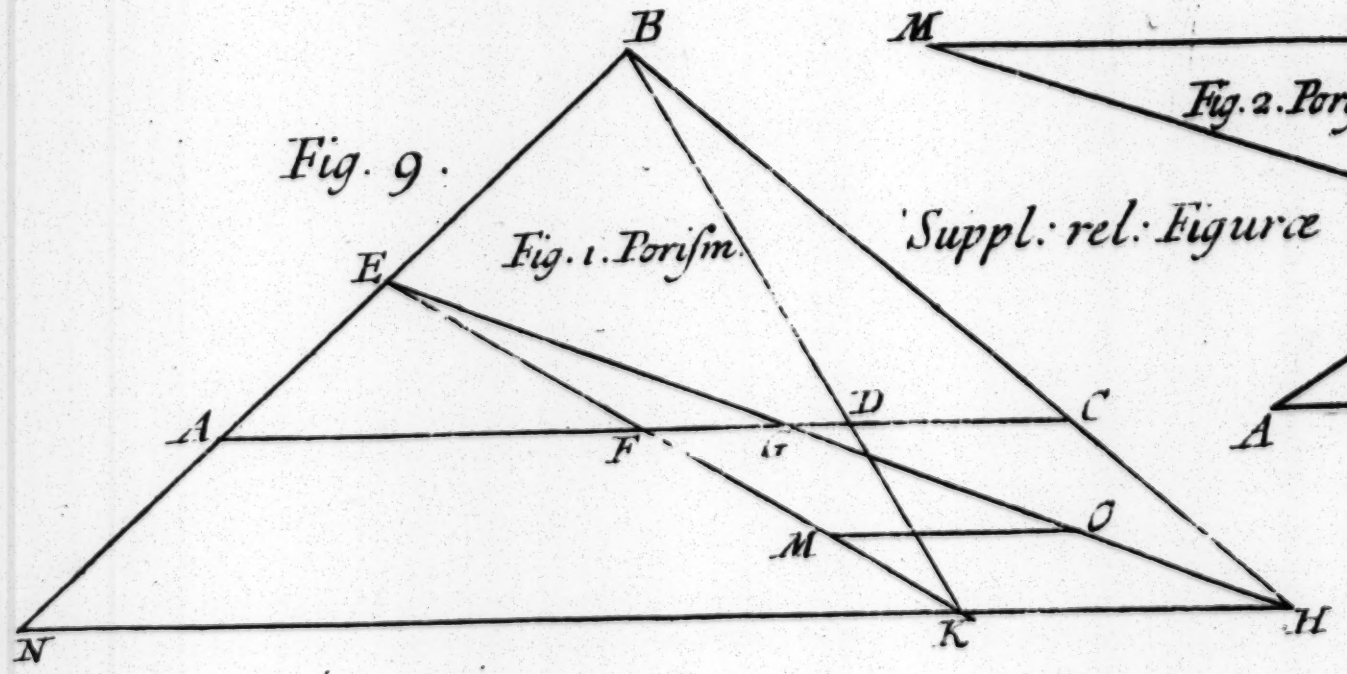


Fig. 9.

Fig. 1. Porism.

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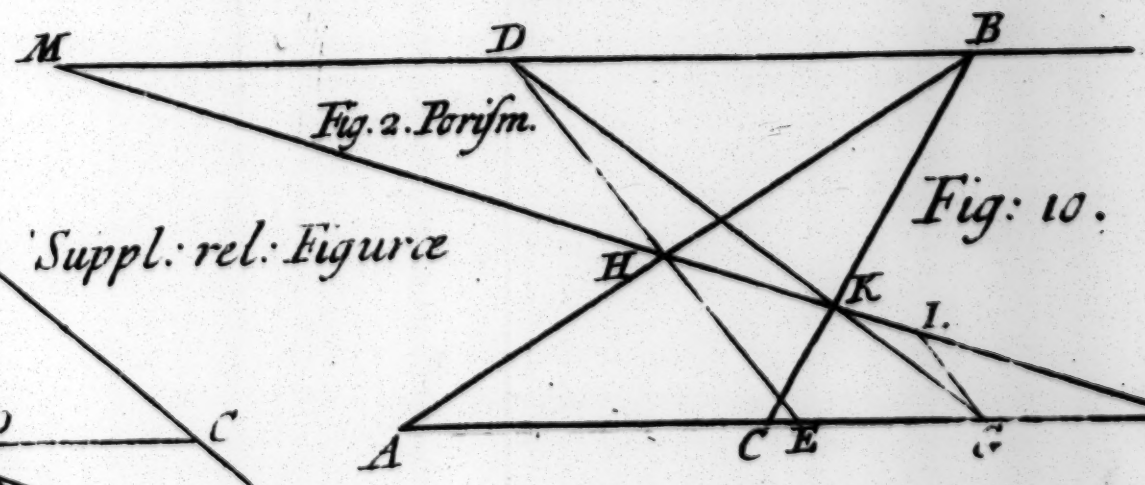


Fig. 2. Porism.

Fig: 10.

Fig. 11.



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VII. *De Globulorum Sanguineorum magnitudine, &c. ex Epiſtola D.* Antonii a Leuwenhoek *ad* Jacobum Jurin, *M. D. R. S. Secr.*

DELPHIS, 19 *Martii*, 1723.

EX tuis litteris intellexi inventam tibi rationem eſſe, qua diametros globulorum ſanguineorum, aliarumque minutiſſimarum rerum, certo cognoſcere poſſis, adeo quidem ut deprehenderis diametrum globuli ſanguinei cum parte $\frac{1}{1940}$ lati pollicis magnitudine convenire.

Hoc ego inventum cum legerem, ſumma voluptate affectus ſum; ſtatimque ſic mecum ratiocinabar: ſi 1940 globulorum ſanguineorum diametri lato pollici longitudine reſpondent; adhæc ſi corpora inſtar globi rotunda eam ad invicem proportionem habent, quam habet numerus cubicus ad ſuum axem, ſicut a Geometris traditur; ſequitur corpus, quod ex 7301384000 globulorum conjunctione componitur, haud majus eſſe corpore globoſo, cujus axis latum pollicem longitudine adæquet.

Et quia de examinando denuo ſanguine me rogaveras; meum ipſius & duarum præterea perſonarum ſanguinem viſu exploravi: planeque comperi 4 diametros globulorum ſanguineorum, uti ſcripſiſti, convenire cum diametro [a] fili argentei, quod mihi mittere dignatus es. Id ſolum dicere habeo, quod globulos quoſdam ſan-

[a] *Hujus fili argentei diametri* 485 *pollicem, ſive duodecimam pedis Loudinenſis partem, conficiebant; quod compertum fuerat per Methodum in Actis Philoſoph. expoſitam.* No. 355. pag. 761.

guineos, ſed perpaucos, viſu perceperim; quorum quaternæ diametri diametrum fili argentei longitudine aliquatenus excedebant. Verum conjiciebam globulos illos, quos ex pollice per acus punctionem eduxeram, & adhuc calentes vitro imponebam, a rotunditate figuræ nonnihil deſciviſſe ad figuram planam.

Hoc etiam addere habeo, præterquam quod gravis mea ſenectus viſui non incommodare non poſſit, oculum dextrum, magno incommodo meo, aliquantum mihi caligare. Id vero hinc accidere puto, quod plures globuli ſanguinei, in humore cryſtallino innatantes, ante viſum meum vagentur: quorum alii nullo vel confuſo ordine inter ſe conjuncti, alii ſeorſim fluitantes, imaginem quandam mibeculæ in oculo meo effingunt. Cum autem plerumque utar oculo dextro, ſiniſtrum enim inter ſpeculandum facilè claudo, hinc obtuſior mihi viſus eſt quam eſſe ſolebat.

Haud ita pridem, ſcilicet Januario nuper elapſo, circa magnum illud & neceſſarium organum, quod diaphragma vocitamus, vehementi ſum motu correptus; adeo quidem ut adſtantes non parum turbarentur. Cum motus remitteret, & morbi illius nomen exquirerem, Medicus, qui aderat, cordis eſſe palpitationem reſpondit. Ego verò Medicum falli cenſebam; licet enim, durante motu, pulſum arteriæ ſæpius manu explorarem, nullam pulſus acceleratione percepi. Vehemens ille motus, per intervalla recrudeſcens, tres circiter dies duravit; quo tempore ſtomachus mihi & inteſtina in officio motuque ceſſabant; mortemque pro foribus eſſe certiſſime credebam.

Ego vero obſtructionem in diaphragmate hærere judicabam, non minorem nummo imperiali.

Addis in epiſtola tua, prænobilis Domine, quod ovarium exterminare ſtudeam; ad quod ſalva pace reſpondeo,

ſpondeo, iſtum meum conatum non eſſe nuperum vel novellum, ſed me ante 25, & amplius annos in illo evertendo laboraſſe; eo quod opinio, quæ generationem ab ovario arceſſit, mihi prorſus inſulſa videatur. Ego a permultis modo annis tum aliorum animalium, tum avium atque piſcium, maſculina ſemina examinare ſoleo: quod potiſſimum ſub iſtud tempus quotannis facio, cum piſces ova ſua emittunt: Plerumque autem comperi ſemen maſculinum innumerabili ſcatere copia exiguiſſimorum animalculorum; ex iiſque potiſſimum componi. Quare pro certo ſtatui, minutiſſima illa animalcula in iſtius generis animalia, unde exorta ſunt, creſcendo evadere. Anguillas tamen, ſquillas, piſces conchatos, & varias muſcas excipio; quæ omnes ſunt femellæ, & fructus edunt, hac in parte convenientes cum fructibus arboreis: quorum in feminibus Plantulas deliteſcere comperimus; quæ vice maſculinorum ſeminum fructus iterum proferent, fructibus illis congeneres, ex quibus ſemina jam dicta exorta fuerunt.

VIII. *Some Amendments and Additions to the Account of Things found under Ground in* Lincolnſhire, *in the* Tranſactions *of* May *and* June, An. Dom. 1702, Numb. 279. Sect. 4, 5. *By Mr.* Ralph Thoresby, *F. R. S.*

WHEREAS in the Paper aforeſaid, *pag.* 1157. *lin.* 35. and *pag.* 1158. *lin.* 15, 16. there is ſome Difference betwixt the Accounts of the Depth of the Things found; that in the Letter, *Sect.* 5, accounting it to be about 8 or 10 Foot, and that in the Letter, *Sect.* 4. to be 12 or 14 Foot deep; the Reader may pleaſe to underſtand, that the Depth was not meaſur'd, but conjectur'd, and accounted for according to the Relator's beſt Remembrance. That which makes the Depth the greater being that of *Sect.* 4. (firſt placed, but laſt wrote) was wrote upon Information (but by Conjecture alſo) of another that lived near the Place, and view'd it often. But the Difference may eaſily be accommodated or ſalved, by ſuppoſing (which will not be far from Truth) that when the Labourers or Dikers firſt diſcovered and encountred the Jetties and other Things there found, it might be about the Depth of 8 or 10 Foot; but the Bottom of them, when they came to be all taken up, might be at the Depth of about 12 or 14 Foot, as in the other Relation.

Take notice alſo, concerning what is ſaid *pag.* 1159. *lin.* 14. that ſome, and thoſe very judicious Perſons, ſay, that the Stones which the Spectators ſaw at the Bottom of *Hammon Beck*, were ſuch as the Dikers had

firſt

firſt thrown out, (when they were taking up the old Goat) and were fallen in again. But that it was a hard and firm Soil is certain; and probably that on which the famous Steeple of *Boſton* ſtands. See the Record of the Foundation of the ſaid Steeple in the *Philoſophical Tranſactions*, *Numb.* 223. *pag.* ~~243~~. 347

The Form of the Shoe Soles found at *Spalding* was after this Manner, (*Vid. Fig.* 11.) each Foot had its proper Shoe: This was for the right Foot.

Now, by ſome Paſſages in Hiſtory, it may probably be conjectured, when thoſe Shoe Soles were left there, and how long it may be ſince that Atterration, that makes the preſent Country, began. Take an Inſtance or two.

In *Stow*'s Chronicle, *ad An.* 1465. we read of a Proclamation againſt the Beaks or Pikes of Shoone, or Boots, that they ſhould not paſs two Inches upon Penalties there mentioned. And by other Paſſages in Hiſtory it appears, that thoſe Pikes of Shoes were before that time exceeding long, and held up by Chains, that they might not hinder the Wearers going; which Chains or Ligaments were ſometimes of Silver, if not of Gold, that they might be rich, as well as ornamental. The other Inſtance is this.

In *Melchior Adamus*'s Life of *Conrad Pellican*, at the Bottom of *Page* 263, in the *Octavo* Edition, there is this Paſſage. *Illo ipſo tempore* (*viz. An.* 1484.) *milites ex* Flandria *reverſi multa nova introduxerunt, nempe variegatas caligas, obtuſos calceos, qui antea acuti geſtabantur a viris & mulieribus, ſimul quoque novum ſandaliorum genus obtuſum, quod vocabant* **Pantoffeln**, *quibus ſuos etiam parentes uti conſpexit, omiſſis paulatim calopodiis* **Holzſchuh** *dictis: quæ quidem novitates interim immenſum creverunt.*

Now

Now by this Account it appears, that it is not much above 200 Years ſince thoſe Shoes, before deſcribed. were worn; and conſequently it cannot be much longer, ſince the Earth hath been raiſed there to the Thickneſs before mentioned, *viz.* of 10 or 12 Foot; and ſince *Bicker* Haven grew up to be (as now it is) higher Land than the Country on each Side of it. By which may be conjectured, what a Change a Century or two more may make in the Out-falls of the Rivers of *Witham*, *Welland*, *Nyne* and *Ouſe*; and conſequently the Neceſſity of taking ſome other Method for preventing the impending Miſchiefs, which threaten the Navigation of the ſaid Rivers, and thoſe who have Eſtates and Intereſts in the great Level of the Fens, and are concerned about the Draining of them.

IX. *An Account of a monſtrous double Birth in* Lorrain. *Communicated to the Publiſher by Mr.* Colin Mac Laurin, *Prof. Math.* Abredon. *R. S. S.*

I The Underwritten, Surgeon in Ordinary to his Royal Highneſs the Duke of *Lorrain*, certify, that on the laſt of *December*, 1722, I went by his Orders to *Domp Remy la Pucelle*, to ſee there *Sebaſtiana Camus*, aged 44 Years, delivered on the 24th of the ſaid Month, being *Chriſtmas* Eve, about eight o'Clock in the Evening, of two Children, or Twins, joined together in the Manner as appears by the Draughts, (*Fig.* 1, 2.) *viz.* There is one Head, one Neck, one Breaſt, one *Abdomen*, and two Hands on one Side; and there are as many Parts on the other; the whole being well proportioned and plump, joining together by the Belly, which is common to both, ſo that one of the Heads is

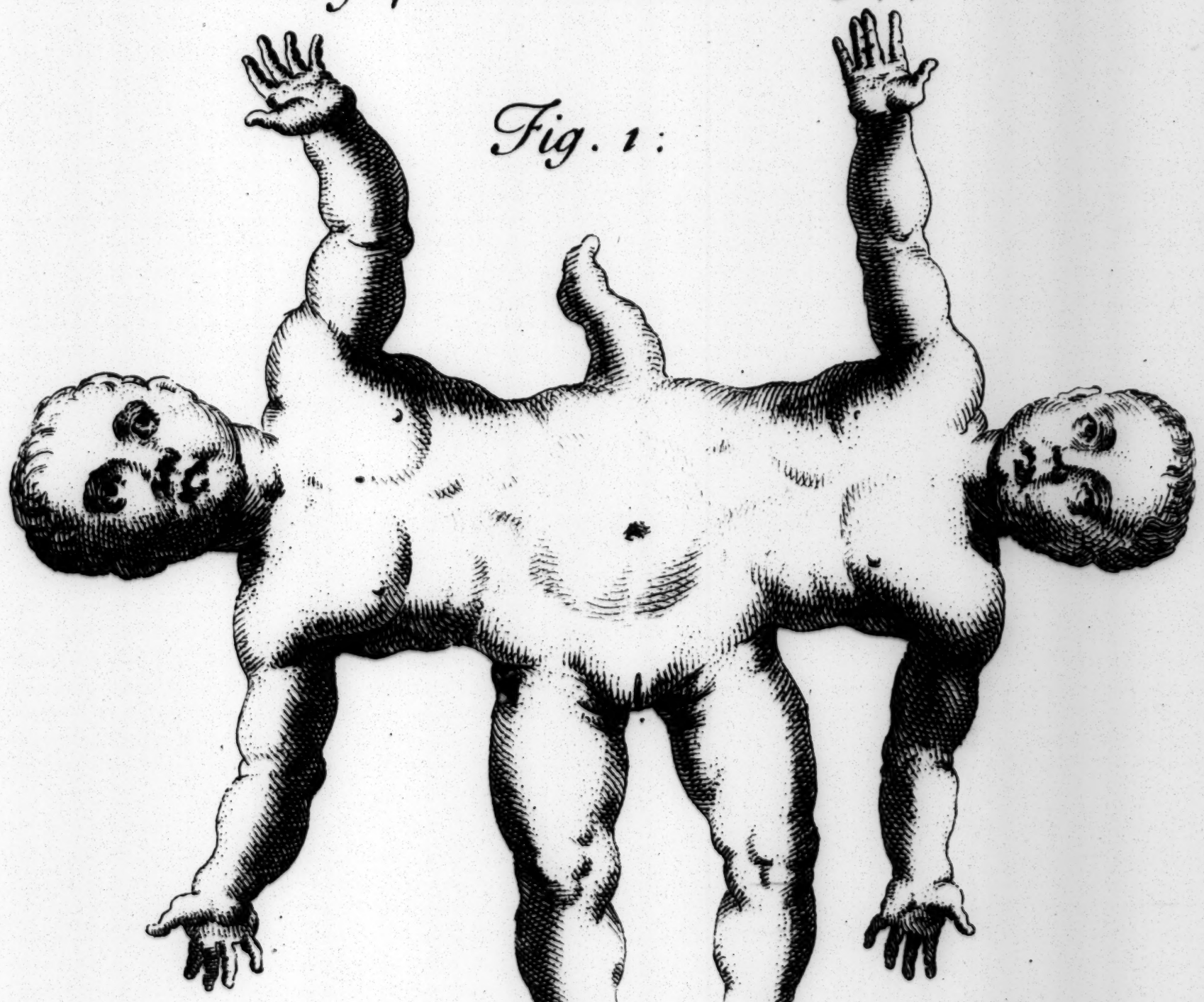
1723. IV. 3.

FEVRY.

By

Philosoph: Transact N.o 377.

Fig. 1:



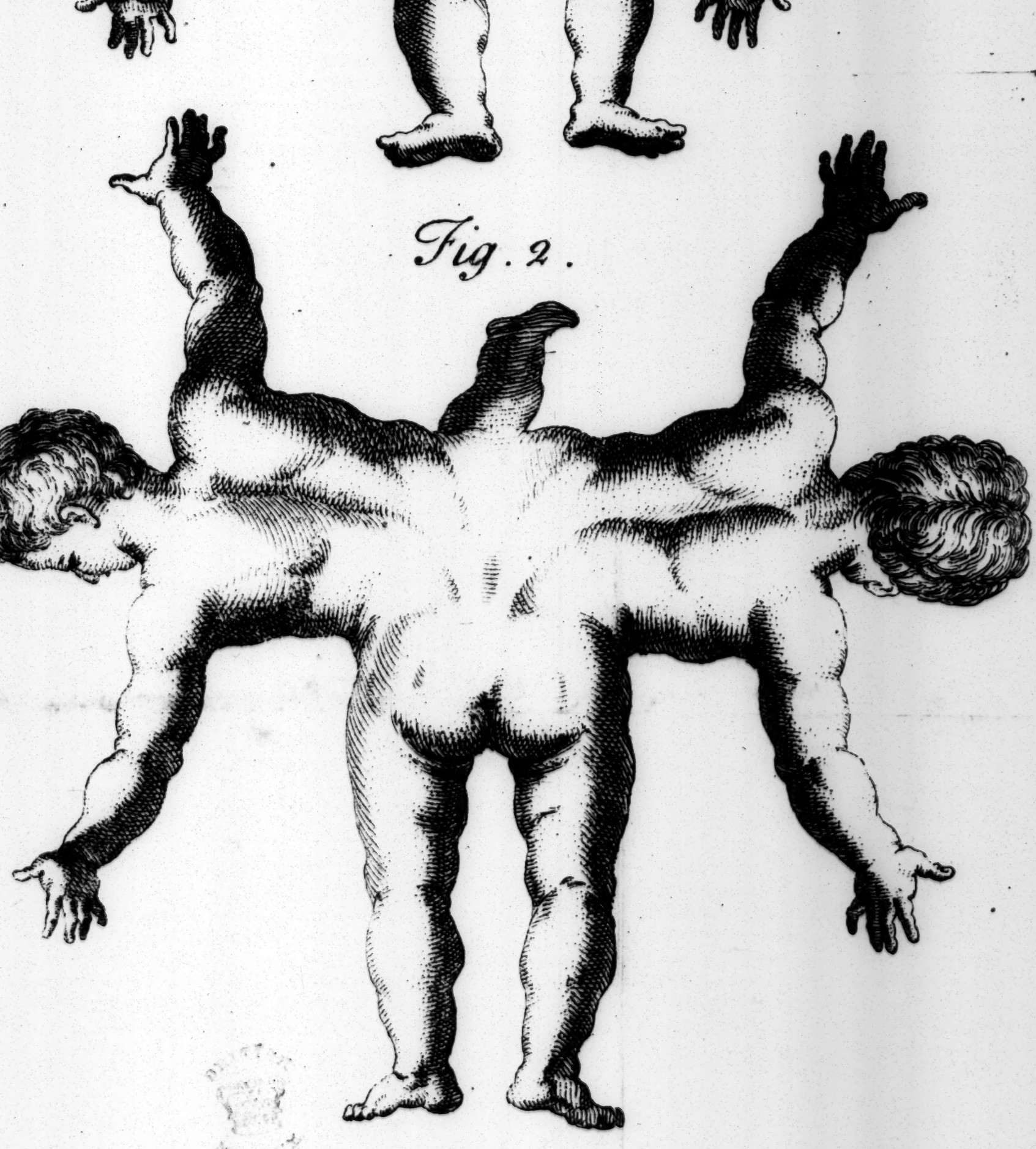


Fig. 2.

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in the Place where the other's Feet ſhould be, and the other Head is in its natural Place; they have but two Legs for both of them, which ſeem to ariſe from the tranſverſe *Apophyſes* of the *Vertebræ* of the Loins on one Side; and from the oppoſite Region of the Loins, comes out a Leg ending with a Joint which bends forwards, and at the the Extremity forms a ſmall Stump, like a Finger, articulated by *Ginglymus*. There is but one Fundament for both, by which they void their Excrements; they have but one Navel-ſtring, and the Parts proper to the Female Sex are alſo ſingle: They eat and drink with their Mouths ſeverally, and while the Breaſt is given to one, the other cries for it: They ſleep and are awake, ſometimes both at the ſame time, ſometimes ſeparately. Each of theſe Children has been baptized: one of them is ſomewhat plumper than the other, which is more puny, and not ſo freſh-colour'd. The Head of the one, which is a little bigger than that of the other, came firſt to the Birth, the two Arms lying on the Breaſt followed next; the Legs lay on the Sides of the Breaſt of the Second; the oppoſite Leg, which is ſingle, was extricated afterwards; laſt of all, the Arms of the ſecond Child, being ranged on the Side of its Head, made it eaſy for the reſt to come out. The Bodies of both theſe Children make no more in Bulk than that of one ordinarily does.

It is obſervable, that the Mother can aſſign nothing that had had any relation to this Event, during the Time of her Pregnancy.

I am juſt now informed, that both theſe Children are equally well in Health.

NANCY, *the* 21*ſt of* January, 1723. *N. S.*

FEVRY.

By

By another Account communicated to the Royal Society, *we are inform'd, that these Children lived two Months after the Birth.*

Fig. 1. Represents the fore View of the Twins.
2. Their Back-part.
3, & 4. The Skeleton.
5. The Breasts and Abdominal Muscles, after the external Teguments were removed.
6. Part of the *Viscera* of the *Abdomen.*
7. The Urinary and Genital Parts.

The two first Figures were drawn in their Life-time, and the five following were taken after their Death, by Order of his Royal Highness the Duke of Lorrain.

X. *Observations and Experiments on the* Sal Catharticum Amarum, *commonly called the* Epsom Salt. *By Mr.* John Brown, *Chymist, F. R. S.*

THAT the Salt, of late Years distinguished by the Title of *Sal Catharticum*, is made from what, at the Salt Works, is called *Bittern*, is pretty commonly known; but the particular Manner how this *Bittern* is produced, and from it, these Salts, has not yet, as I know of, been communicated to the World, in such a Manner, as to become intelligible. And the *Opprobrium* unjustly cast upon the Salt, of its being a counterfeit *Epsom Salt*, or something made in Imitation of it, or common Salt dissolved and recrystalized, has



Fig. 3.

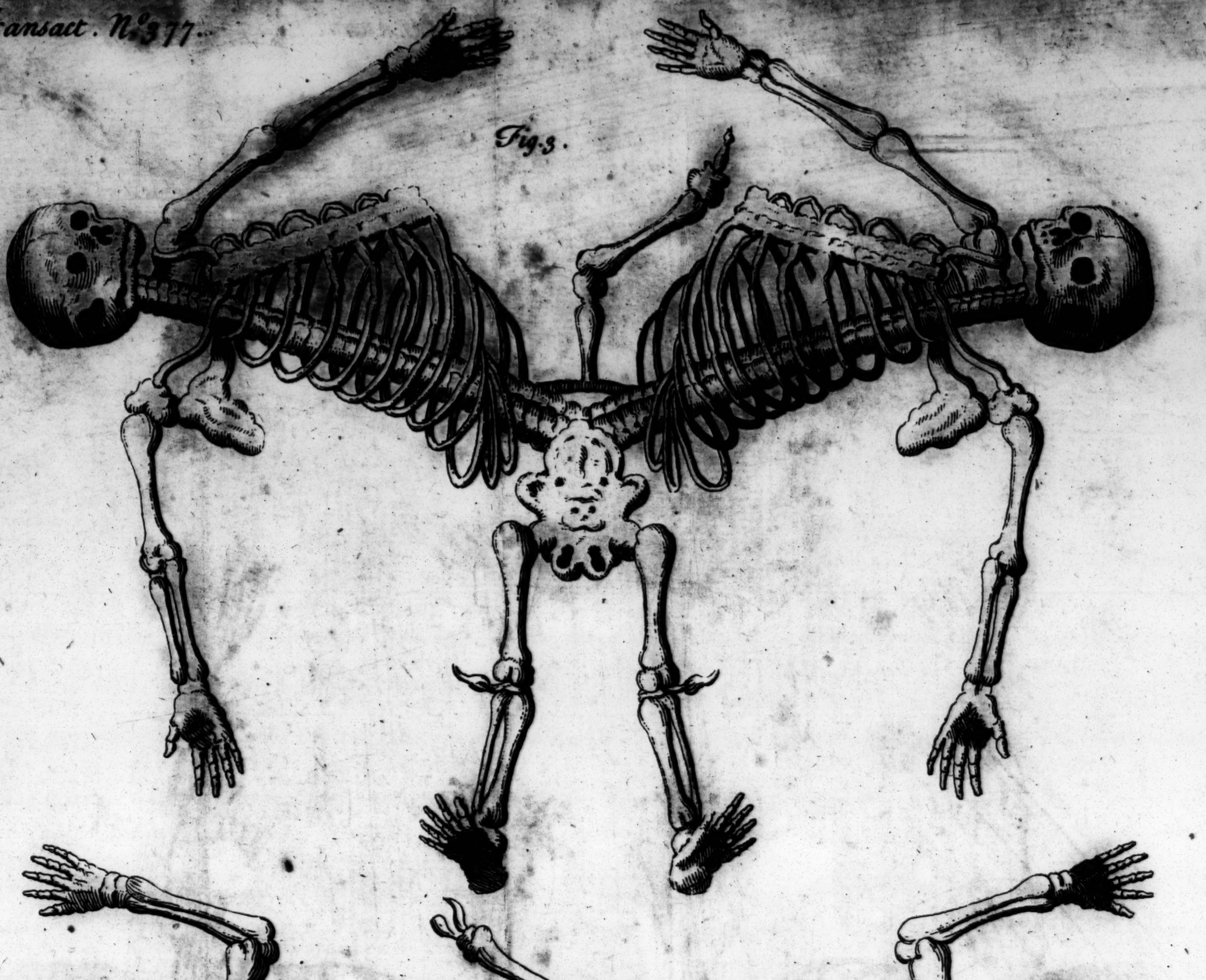
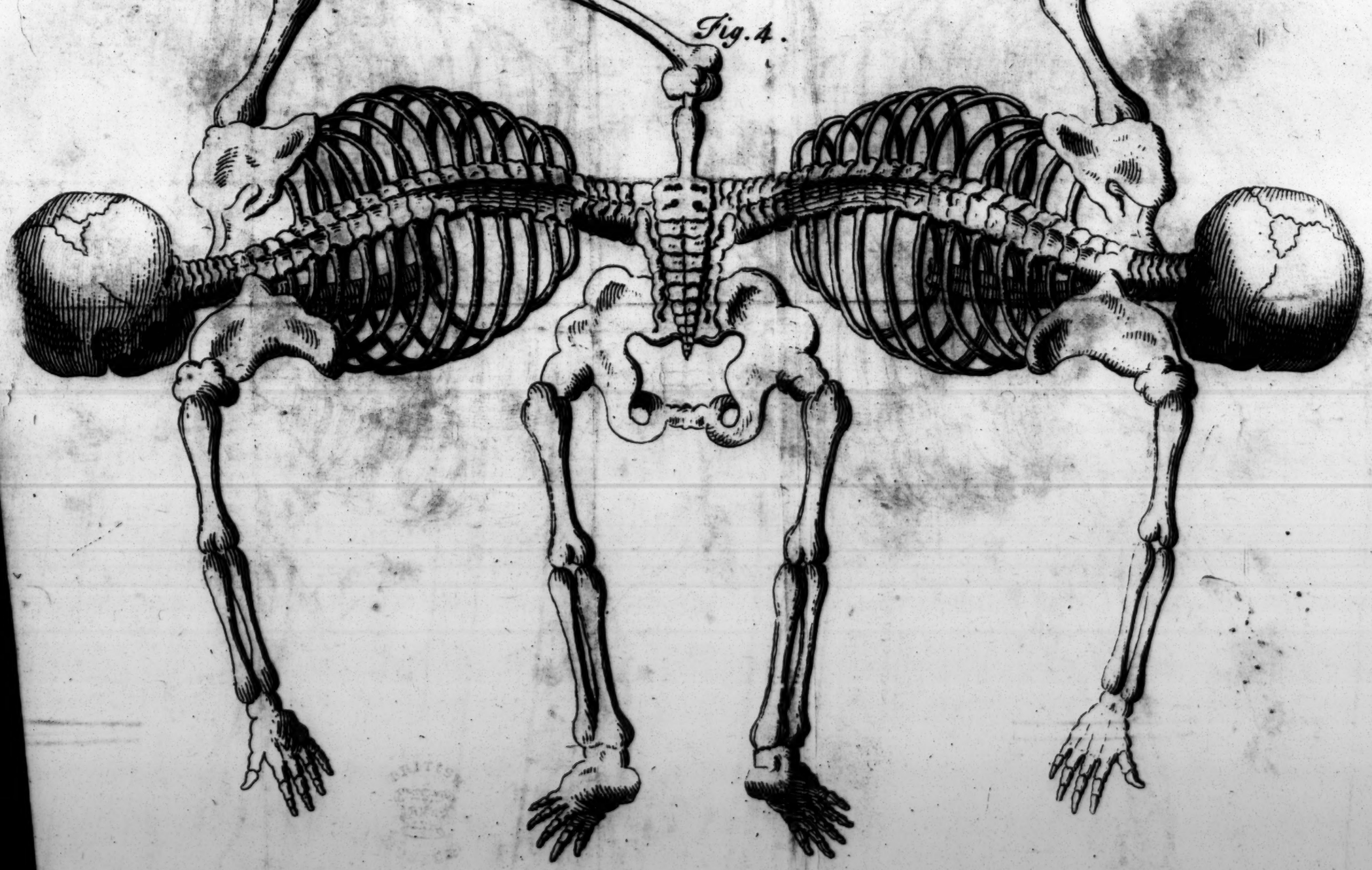
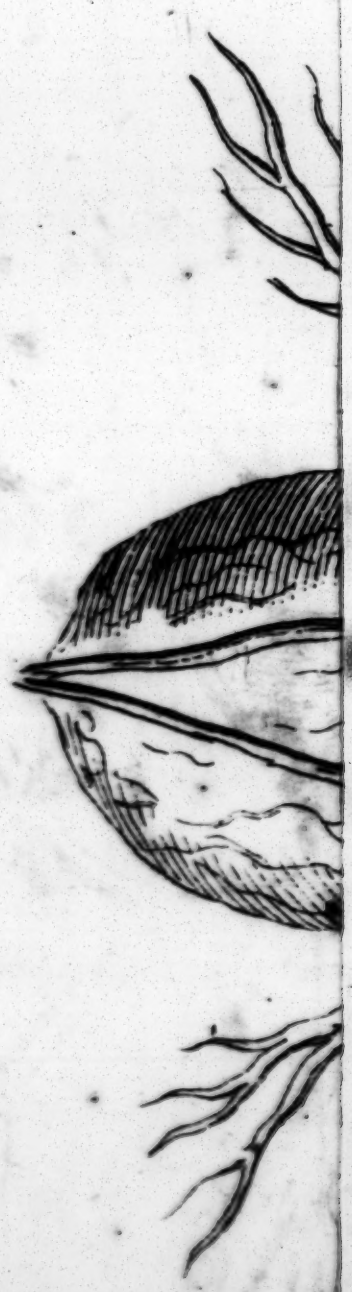
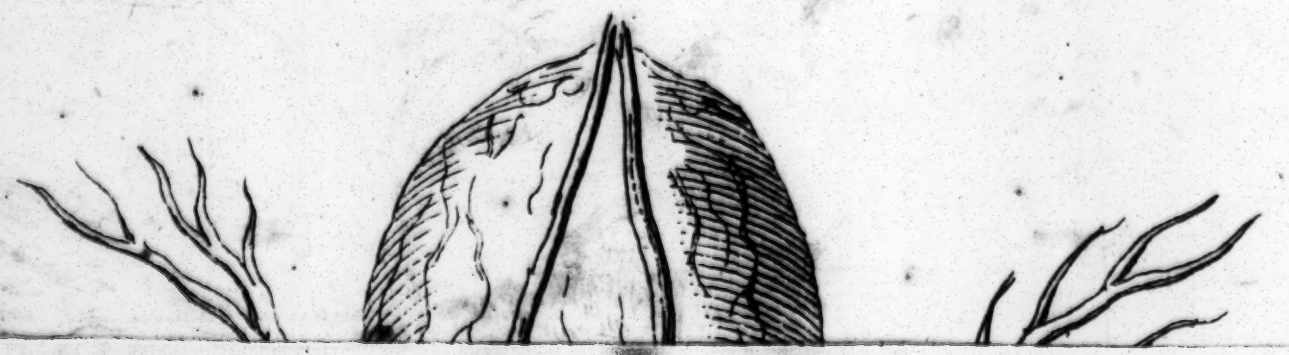


Fig. 4.







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Fig. 5.

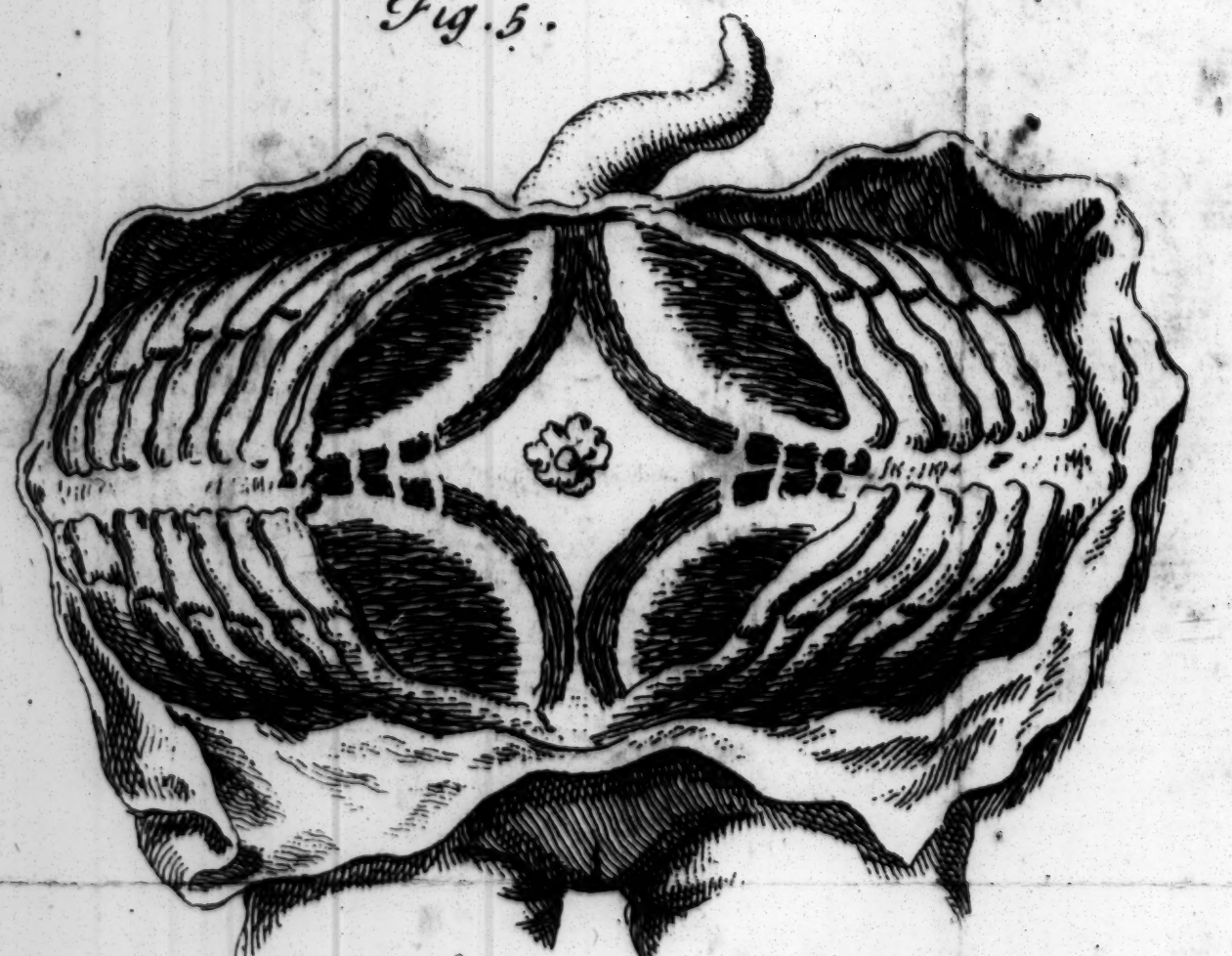
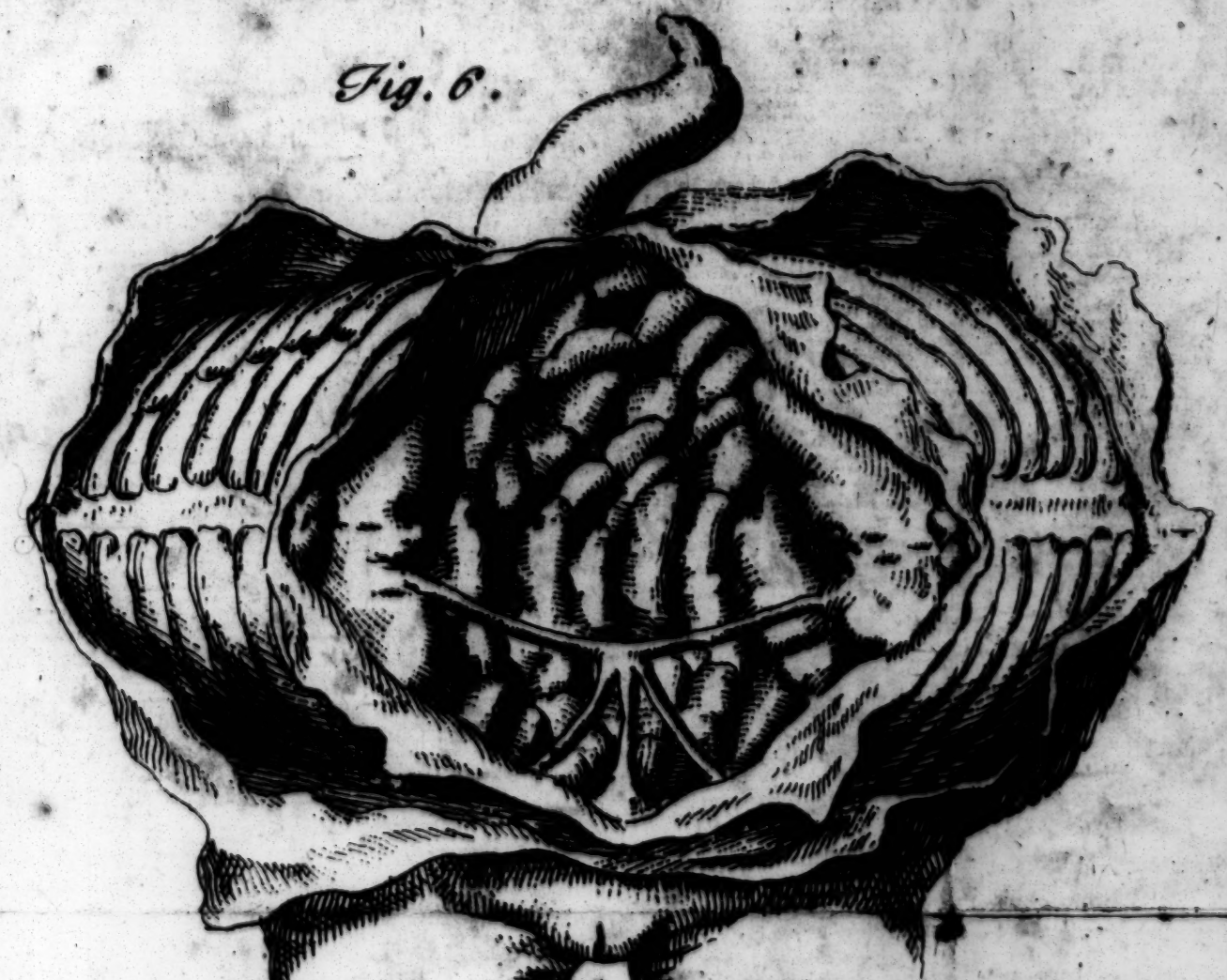


Fig. 6.



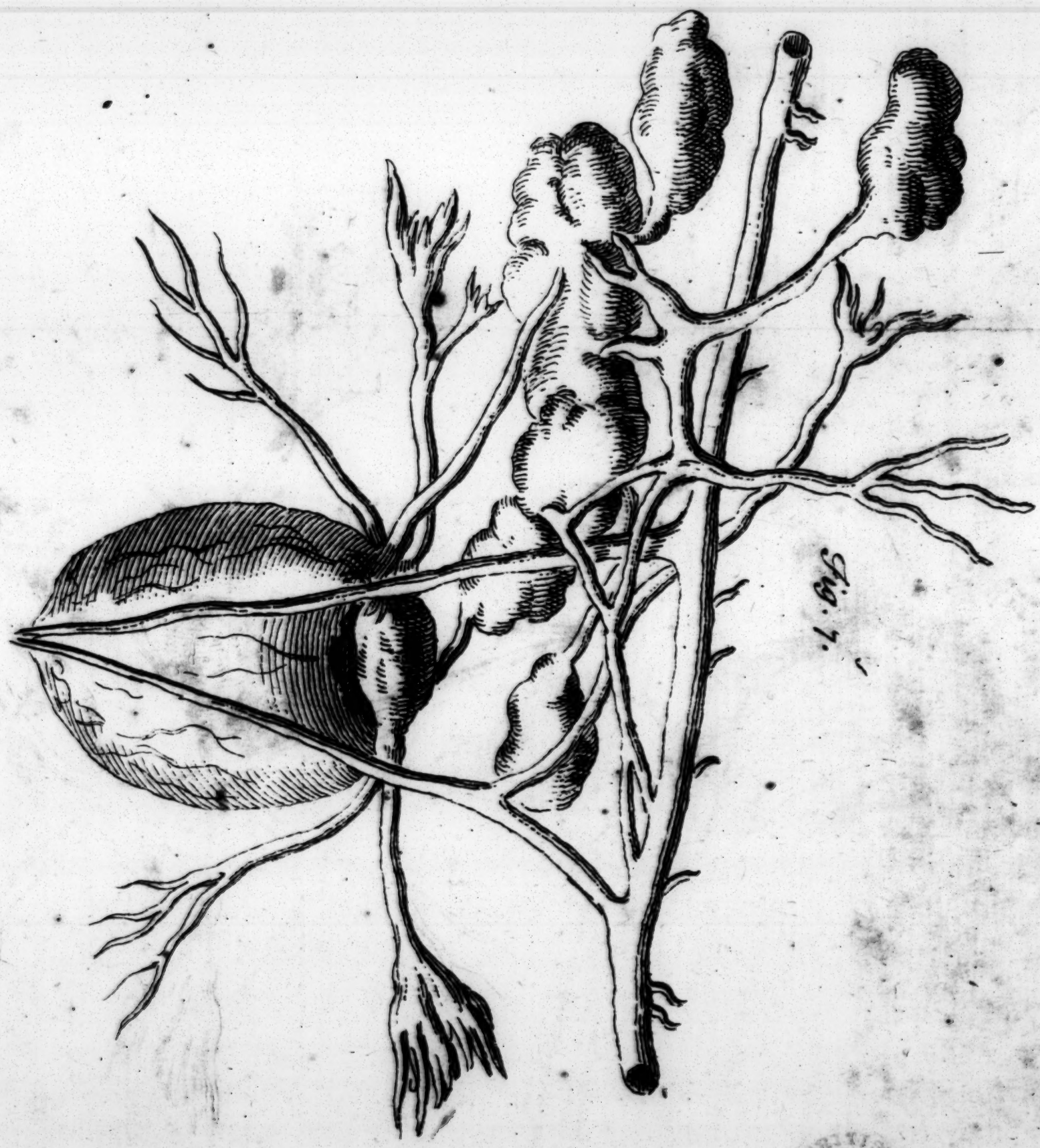


Fig. 1.

very much ſunk its Eſteem among the Learned in Phyſick.

By the Account M. *Bolduc* gives no longer ago, than in the Hiſtory of the Royal Academy of *Paris*, for the Year 1718, I find he did not ſucceed according to his Wiſh in the Experiments he try'd, to find out what this Salt was made from, juſtly grounding his Reaſons for its not being all made from the *Epſom* Waters, or other Springs that afford bitter purging Waters, becauſe of the large Quantities conſum'd, and the Cheapneſs of its Price. After all his curious Endeavours, it ſtill remain'd a Secret, until the Information he received from hence by Dr. *Mendez*, whoſe Account is as follows, though very imperfect. It comes, ſays he, from *Lemington* and *Portſea*, both in *Hampſhire*, where from Heaps of foſſile Salt, there runs a ſaltiſh, bitter, ſharp, and pungent Liquor. One would judge by its Brackiſhneſs and Bitterneſs, that it contained two Kinds of Salt, the one a Sea Salt, the other a bitter Salt. To ſeparate theſe Salts, they cauſe this Liquor to run through hollow Drains on the Ground; there it gets together, and condenſes into Salt; this they put into a large Veſſel, with a great Quantity of common Water, and boil it as long as is ſufficient to diſſolve it; then they let it cool and ſettle for ſeveral Days. The Water, impregnated with the Sea Salt, which is the heavieſt, ſinks to the Bottom of the Veſſel with the earthy Parts, and the Water impregnated with the bitter Salt, which is the lighteſt, ſwims at Top. They take off this upper Liquor, as long as it retains its bitter Taſte, without any Pungency; afterwards they boil it in one or two Waters, then evaporate it, and it yields white and tranſparent Cryſtals, which are the counterfeit *Epſom Salt*.

What Experiments M. *Bolduc* made with the *Bittern*, ſent him by that Gentleman, I do not remember to have met with, in any of the ſucceeding Memoirs.

Dr. *Seipp*, in his Deſcription of the *Pyrmont* Waters, *Page* 127, ſays, that the common *Engliſh* purging Salt, which is ſold in great Quantities in *Germany*, under the Name of *Epſom Salt*, is not prepared from the *Epſom* Waters, but is made in *London* from common Sea Salt, and Oil of Vitriol.

In the ſame *Page* he ſays, that the Salt obtain'd from the *Pyrmont* Waters will part with its own acid Spirit, upon pouring on the *Ol. Vitriol.* which the *Sal Mirabile* and the *Engliſh* purging Salt will not. By this Means he diſtinguiſhes the firſt Salt from the two laſt.

Dr. *Quincey*, in his *Prælectiones Pharmaceuticæ*, publiſh'd ſince his Death, ſays, there hath lately been contriv'd a Salt from the Mineral Purging Waters, made by Evaporation, Filtration, and Cryſtalization. It was firſt entitled *Sal Mirabile*, or *Sal Catharticum Amarum*; but it is now ſo ſcandalouſly counterfeited, that it is little elſe than common Salt diſſolv'd and recryſtalized.

Before I enter into the Account how this Salt is made, it may not be amiſs, firſt, to ſay ſomething of the genuine Salt that has been made from the bitter purging Waters, of which the learned Dr. *Grew* was the firſt who attempted the making it at *Epſom*. Some Years after, ſeveral other bitter purging Springs were found in different Counties, and Salts in ſmall Quantities were boyl'd up from them, but from no Place, nor all the Places put together, in ſuch large Quantities, as from the Springs on one ſide of *Shooters-Hill* in *Kent*, about the Year 1700, which were then in the Poſſeſſion of thoſe two ingenious Chymiſts, Mr. *George* and Mr. *Francis Moult*; and

and where they made ſuch large *Apparatus* for evaporating the Water, that they have ſometimes boyl'd down 200 Barrels in a Week, from which, in a dry Seaſon, and when the Land Waters did not get into their Drains, they have obtain'd 224 Pound of Salt.

After theſe Works had gone on ſome time, Dr. *Hoy* found out a more expeditious Way of making a purging Salt ſo nearly reſembling that from the purging Springs, in all its Properties, that it ſoon paſs'd on the World for the other, and continued ſo to do.

The great Conſumption of theſe Salts (which then went only by the Name of *Epſom Salts*) as well at Home as Abroad, engaged ſome of our Phyſicians, (many Years before M. *Bolduc* took Notice of it) to ſuſpect, that even what was made at *Shooters-Hill* was ſpurious, and received an Addition of ſomething to encreaſe the Quantity. But theſe Suſpicions, I dare poſitively affirm, were entirely groundleſs, as to the Salts made there, and readily believe the ſame of any other Place, where the Spring Waters were boyled down for Salt. But upon a Conſideration, that there were greater Quantities of this Salt conſumed than all the Places where the Waters were boyl'd could produce, which was the real Fact at that Time of Day, there was ſufficient Room to ſuſpect, that ſome of them were not genuine, as appear'd to be true ſometime after.

For the Secret, which was then in a few Hands, of making theſe Salts cheap, gave thoſe, who had it, an Opportunity of under-ſelling thoſe who made it from the Waters, and, in a Year or two, render'd them incapable of making it to any Advantage, conſidering the Price it was ſold for by the others: So that the Work on *Shooters-Hill* was thrown up, and I believe there has not been 100 Pound of Salt made from the Waters ſince that Time, in any Part of the Kingdom.

Some time before this Work at *Shooters-Hill* was broke up, ſome Pains was taken to diſcover the Secret thoſe had, who ſold the Salt ſo cheap; and upon examining the ſeveral Salts, that were ſold about Town, thoſe diſpos'd of by Mr. *George* and Mr. *Francis Moult*, were certainly genuine, and were therefore a proper Standard to judge of the reſt by. But from all the Experiments then made, there could no material Difference be found between the Salt made from the Waters, and that made by them who were in the Secret. There was indeed a Salt ſold by ſome, which, in the Courſe of thoſe Tryals, was found to be a *Sal Mirabile*, made from the *Ol. Vitrioli* and common Salt, but ſhot into ſuch ſmall Cryſtals, as not at firſt Sight to be diſtinguiſhed from the other.

Neceſſity being the Mother of Invention, it was not long before it was diſcovered, and the Experiment was try'd at the Lady *Carrington*'s Salt-Works near *Portſmouth*; where it was found the ſame Thing could be done, as at another Work, not far from it, and in which Dr. *Hoy* had been concerned.

It was ſome Years after this Salt had been made at *Portſmouth*, before the Saltmakers at *Lemington* attempted, or indeed knew the Method of making it; who are now the greateſt Traders in it, and have ſent ſeveral Ton in a Year to *London*, beſides what has been directly exported from thence.

I remember it to have been the Opinion of the Proprietors of the Salterns near *Portſmouth*, that this purging Salt could not be made at any other Salt-Works except theirs, and that the bitter Taſte in the Salt was communicated from the Earth to the Sea Water, whilſt it ſtood expoſed in their Sun Pans. But Time has

has prov'd this Opinion falſe; for beſides what has been ſaid of its being made at *Lemington*, it was about 4 or 5 Years ago begun to be made near *Newcaſtle*, where it is ſtill continued to be made; and doubtleſs may be made at any other Salt-Works, where the common Salt is made from Sea Water by Evaporation. Whether any Thing of this Kind has been attempted at any of our Inland Salt Springs, either in *Cheſhire*, or *Worceſterſhire*, I am not yet ſatisfied.

There is ſome Difference in the making the common Salt in *Hampſhire*, from that about *Newcaſtle*: At the firſt of theſe Places, in the Beginning of the Summer, at Spring Tides, or at New and Full Moon, the Sea Water is let into their feeding Ponds, which are their *Reſervoirs* for their Summer's Working, and from hence is conveyed into ſmall ſquare Pans, and again, after ſome time, from theſe it is convey'd into larger Pans, or Beds, which they call Brine, or Sun Pans; all which are made of Sea Mud and Earth. In theſe laſt Pans, or Beds, it lies expos'd to the Sun and Wind, in order to exhale the weakeſt Waters; and it is in theſe Beds, if the Weather prove very favourable, that they can make as good Bay Salt as any we have from *France*, and at ſuch a time they never bring their Brine to the Boilers. But if the Weather is not hot enough for that Purpoſe, their Brine is expos'd ſo long in theſe Pans, till it becomes of ſuch a Strength as to ſupport their Eggs, made of Glaſs or Wax, to a certain Height above the Surface of the Brine, which from thence is convey'd into large Store Ciſterns, and then into Boiling Pans made of Iron, where it is boyl'd down (after having been frequently ſcumm'd) to a Sea Salt. 'Tis obſervable, that whilſt the Brine is boyling, there precipitates a hard cruſty Matter, which is partly taken out by Veſſels placed

placed in proper Parts of the Pan for that Purpoſe, and Part of it fixes on the Bottom of the Iron Pan ſo hard, as to be afterwards dug off; and this the Workmen call *Scratch*, and is what Dr. *Collins*, in a former Tranſaction concerning the Sea Water boyl'd at *Sheilds*, calls a Stone Powder. When the Operation for the Sea Salt is finiſh'd, it is taken out hot, and put into wooden Troughs with Holes at the Bottom, through which runs the ſuperfluous Liquor: Under theſe Troughs are ſet other Veſſels (with Sticks fixed in them in a perpendicular Poſture) to receive what runs through. In theſe Veſſels the Liquor is ſuffer'd to continue ſome time, and according to the Quantity of Sea Salt ſtill left in it, will cryſtalize to the Sticks, ſomething like Sugar-candy, but in much larger Shoots; and this they call *Cat-Salt*, or *Salt-Cats*, and it holds ſome ſhare of the bitter Salt. When this Salt is broke ſmáll, or rather powder'd, it is ſo white, that ſome Gentlemen chooſe it for their Tables; but the greateſt Conſumption of it is among the Cake Soap-Boylers. The Liquor that will not ſhoot to theſe Sticks, is what at theſe Works, they call the *Bittern*, fit for making the *Sal Catharticum*.

The Remainder of this curious Paper ſhall be communicated in our next.

LONDON: Printed for *W.* and *J. Innys*, Printers to the *Royal Society*; at the *Prince*'s-*Arms*, the Weſt End of St. *Paul*'s Churc -Yard.

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Numb. 378.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *July* and *August*. 1723.

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I. *Florum*

Fig: 1

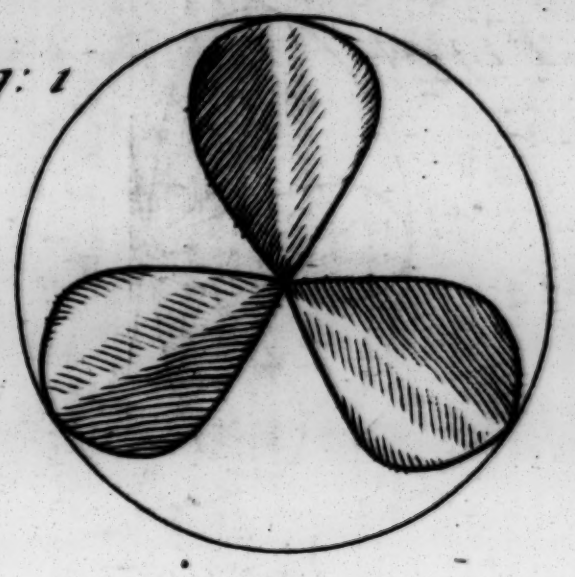


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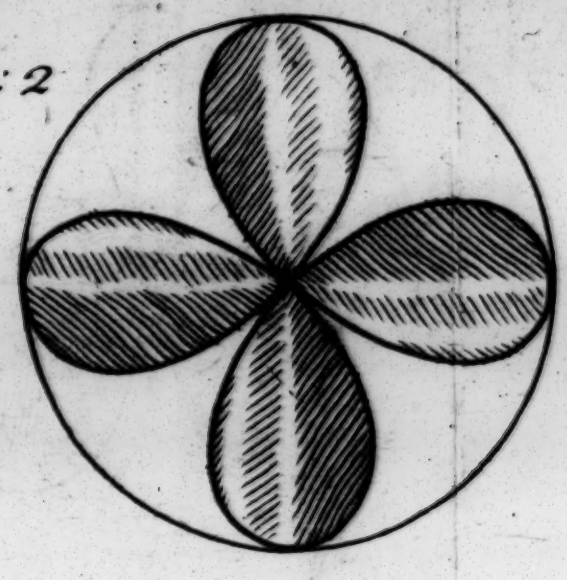


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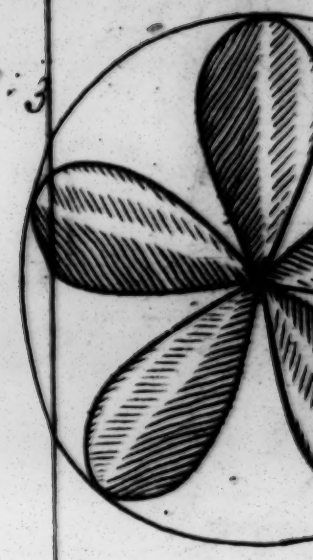


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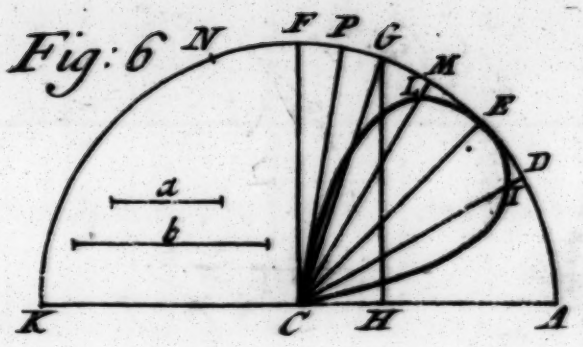


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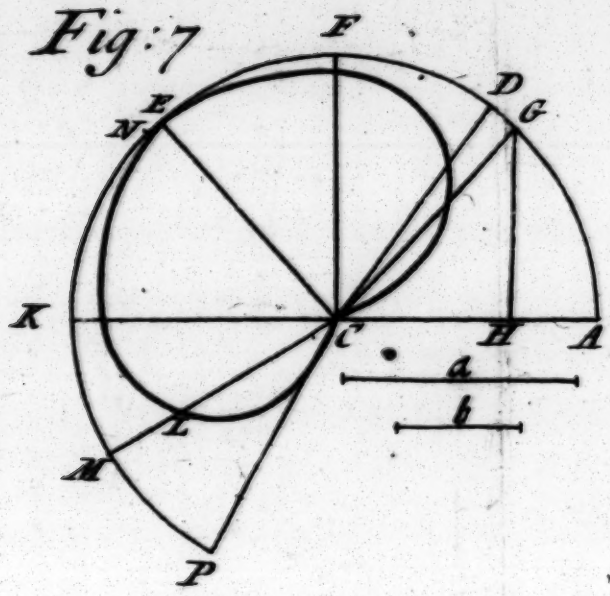


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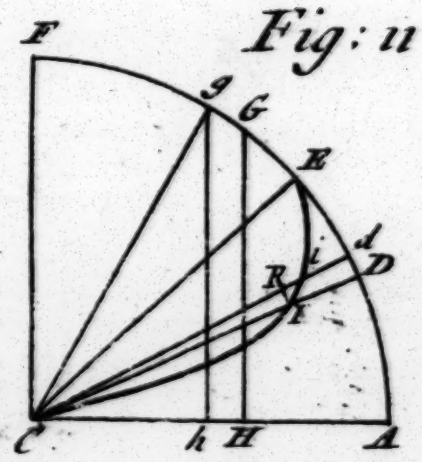
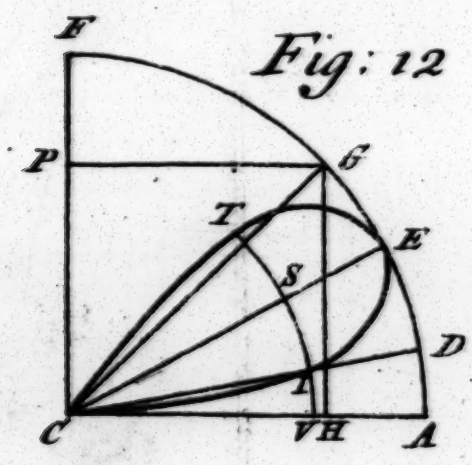


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Fig: 16

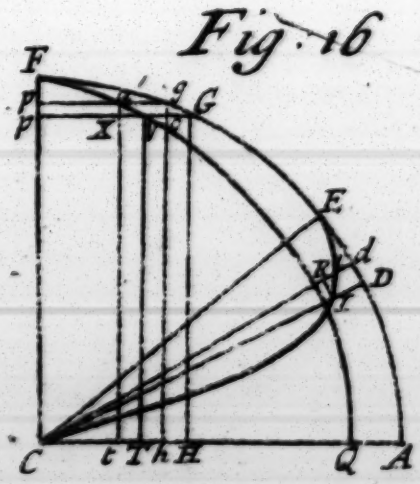


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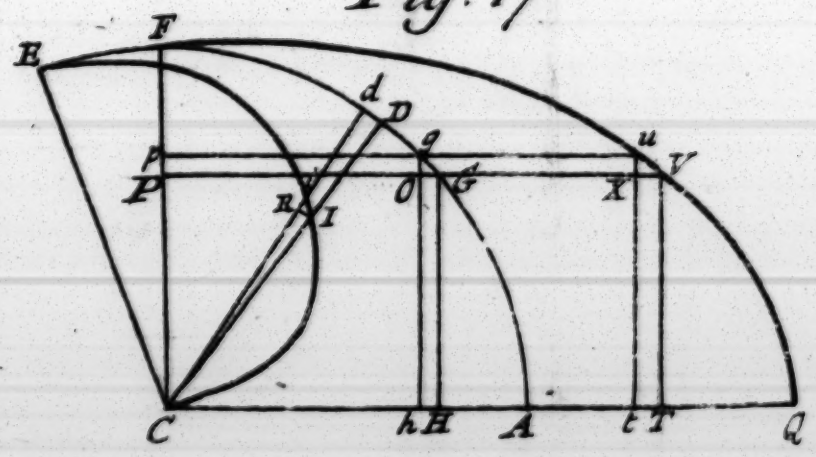


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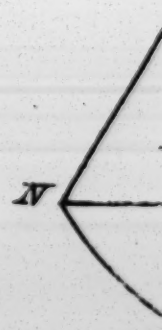
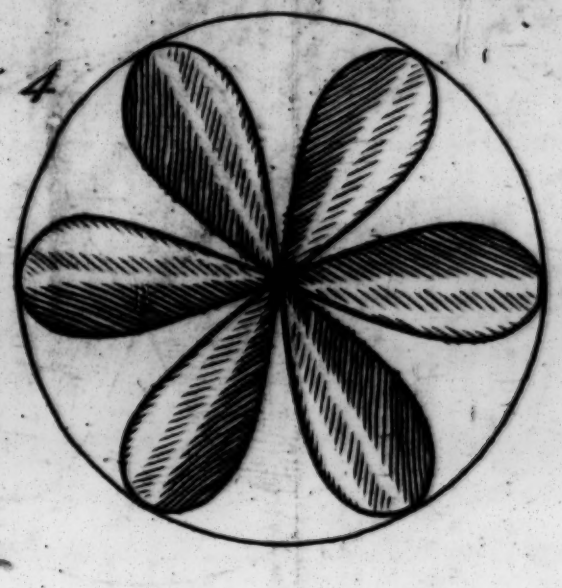
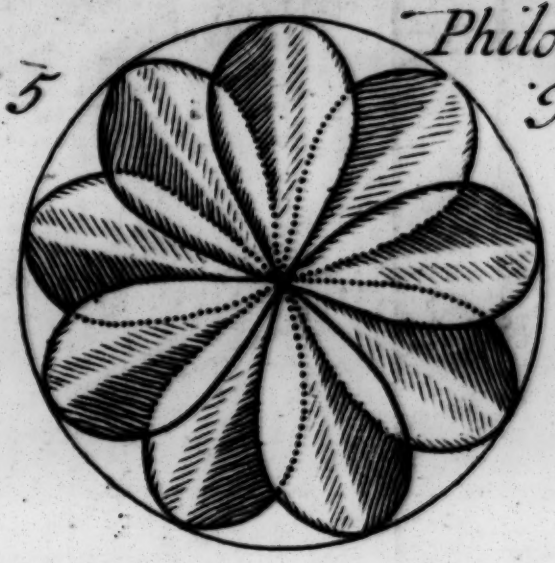


Fig: 4



Fig: 5





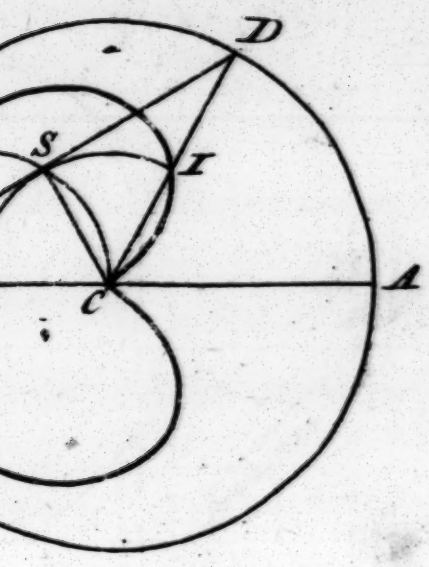


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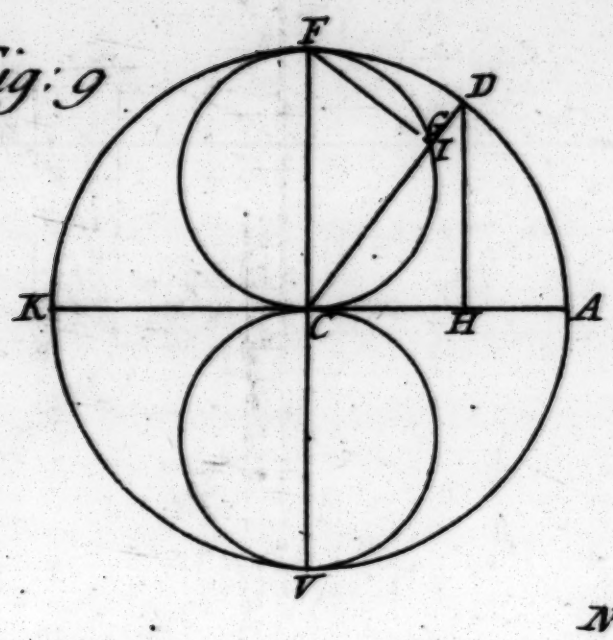


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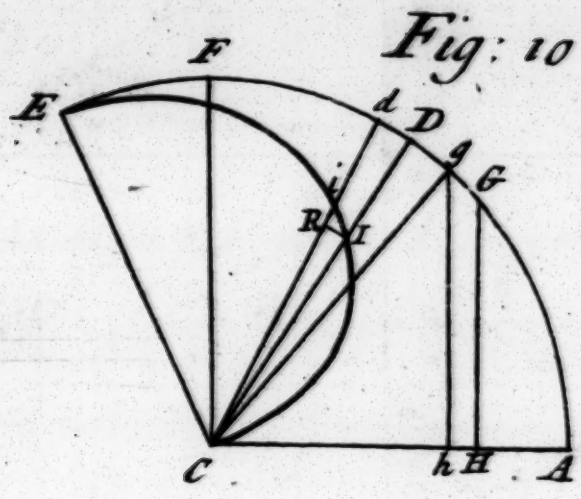
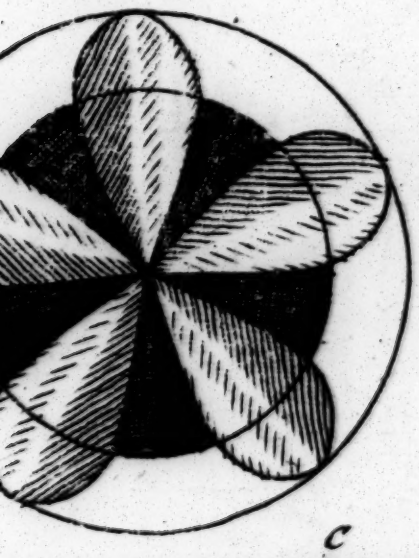


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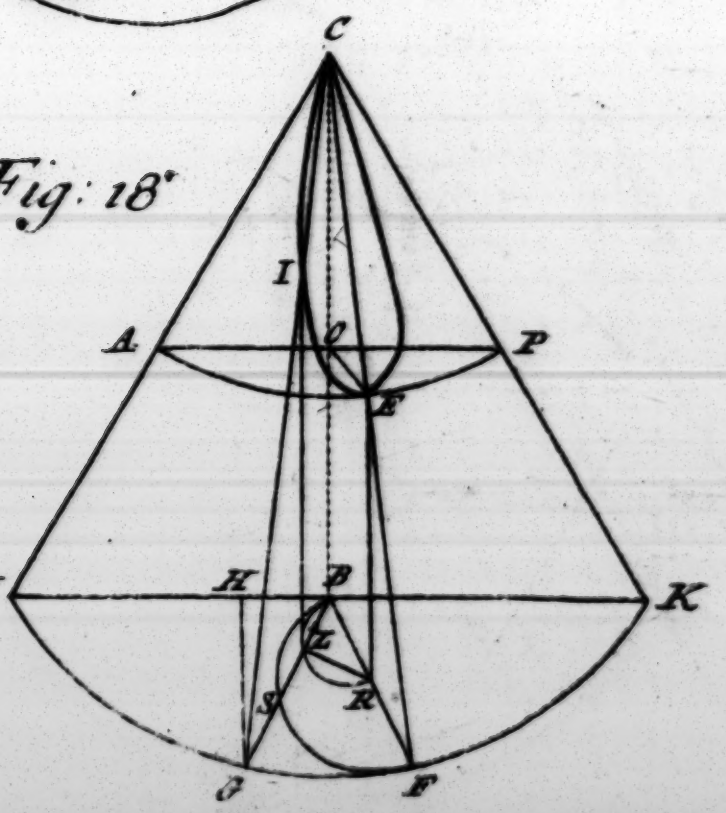


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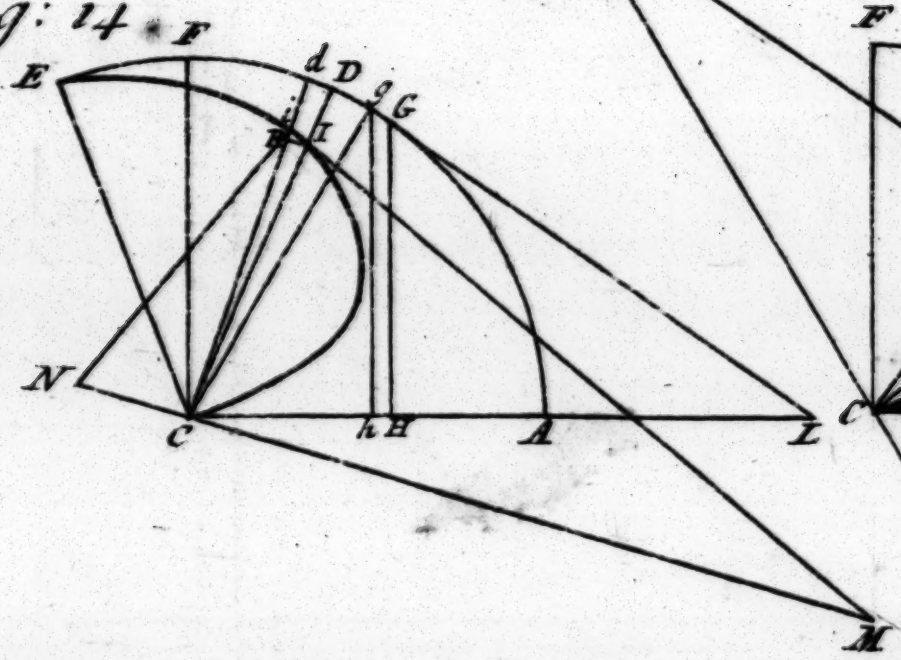


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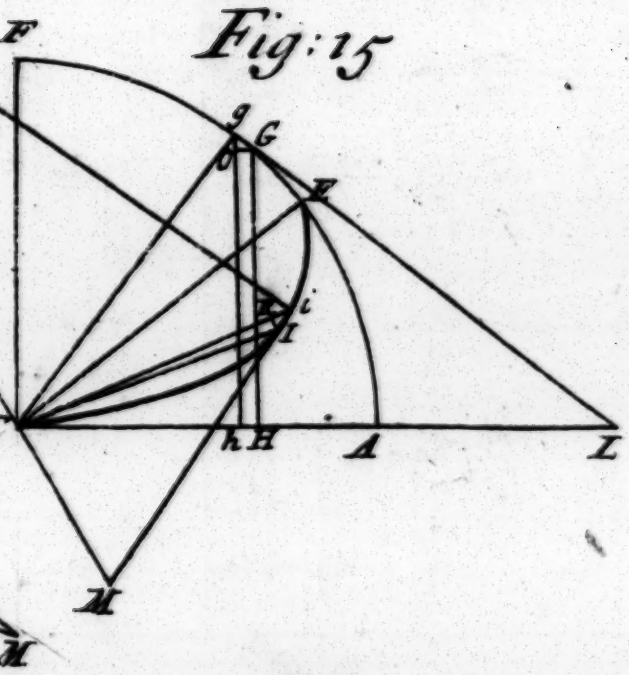


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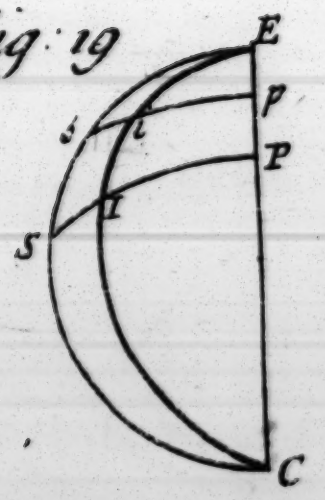
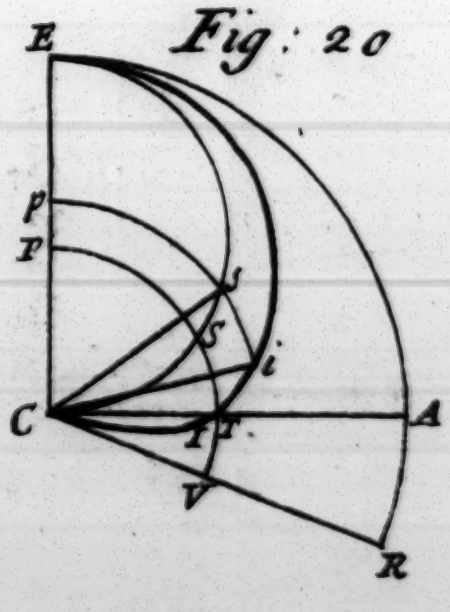


Fig: 20



I. *Florum Geometricorum Manipulus Regiæ Societati exhibitus à* D. Guidone Grandi *Abbate Camaldulenſi, Piſani Lycæi Mathematico, R. S. S.*

SUOS Geometria hortos habet, in quibus æmula (an potius magiſtra?) naturæ ludere ſolet, ſua ipſius manu flores elegantiſſimos ſerens, irrigans, enutriens, quorum contemplatione cultores ſuos quandoque recreat, ac ſumma voluptate perfundit. Hos inter bonis avibus & ipſe quondam admiſſus, nonnullos decerpſi flores, vario frondium numero coronatos, quandoque & infinitis foliis ſibi per innumeros gyros circumpoſitis elegantiſſimè compactos, quorum exiguum hunc ſaltem manipulum vobis, Viri Clariſſimi, offere ſtatui, ut meum vobis obſequium aliquo argumento teſtatum facerem. An naturæ induſtria ſimili fortaſſe artificio florum, fruticum, arborum folia conſtruere ſatagat, tali proportione ſucci nutritii motum temperans, ac dirigens, ut eadem frondium figura dimanet, quales in variis ejuſmodi florum geometricorum foliis, juxta varias leges, quibus deſcribuntur. obſervare licet, Philoſophis diſcutiendum, ac decidendum relinquo, præcipuè verò ſolertiſſimis naturæ indagatoribus, qui magni *Neutoni* exemplo naturales leges ex profundioris Geometriæ principiis repetendas ſibi meritò perſuadent, quibus utique illuſtriſſimus cætus veſter, præ aliis maximè abundat. Valete.

DEFINITIONES.

I. *Flores Geometricos* generatim appello quaſlibet figuras curvâ quadam per aliquot foliorum, ſeſe ab uno centro expandentium, perimetrum recurrente circumſcriptas, quales exhibent Figuræ 1, 2, 3, 4, 5; quos quidem flores, pro numero foliorum, bifolios, trifolios, tetrafolios, pentafolios, exafolios, &c. licebit nuncupare.

II. Cùm porrò innumeris modis ejuſmodi flores generari poſſint, eam geneſim hic ſpeciatim conſideramus, quæ per ramos a centro floris prodeuntes, æquales verò ſinubus angulorum, iis angulis, quos cum data poſitione linea rami comprehendunt, in data aliqua ratione proportionalium, procedit: cujuſmodi curvas *Rhodoneas* dudum appellavimus, eamque proportionem *Rhodoneæ* cuilibet propriam dicimus.

III. *Rhodoneam ſimplicem* appellamus, quæ una circulatione perficitur, *duplicem* quæ duplici, *triplicem* quæ triplici, & ſic deinceps pro numero circulationum.

Itaque ad Rhodonearum deſcriptionem aſſumpto quolibet circulo, cujus centrum C (*Vid. Fig. 6, & 7.*) & ducto ubilibet radio C D ad radium poſitione datum C A utcunque inclinato, ſit angulus A C D ad angulum A C G (ſive arcus A D ad arcum A G) in data ratione *a* ad *b*, ductoque ſinu G H, fiat C I æqualis G H; erit punctum I ad Rhodoneam ſupra definitam.

Ejuſmodi Rhodonearum proprietates præcipuas enucleabimus, nec non ſpatia, & perimetros breviter dimetiemur ſequentibus propoſitionibus.

PRO-

PROPOSITIO I.

Si fuerit arcus E A ad quadrantem A F (ſive angulus E C A ad rectum) ut *a* ad *b*, erit E C unus e maximis ramis Rhodoneæ, ſive erit E apex unius ex ejus foliis. (*Vid. Fig. 6, & 7.*)

Nam ex deſcriptione patet, ponendum eſſe ramum C E æqualem F C ſinui quadrantis A F, qui omnium ſinuum eſt maximus.

PROPOSITIO II.

Quodlibet folium Rhodoneæ circa axem C E hinc inde æquali, uniformi, & ſimili expanſione ſpargitur.

Factis enim hinc inde æqualibus angulis E C M, E C D, ob arcus æquales interceptos E M, E D, ſi fuerit arcus A M ad A N, ut A E ad A F, ut A D ad A G, nempe in data ratione *a* ad *b*, etiam reſidua E M, F N, itemque E D, F G in eadem ratione erunt, adeoque cùm antecedentia E M, E D æqualia ſint, etiam conſequentia F N, F G invicem æquabuntur, uti & reſidua ad quadrantes N K, G A, quorum ſinubus cùm æquari debeant rami Rhodoneæ C L, C I, & ipſi æquales erunt; quare ab axe C E hinc inde æquali, & uniformi expanſione ſpargitur quodlibet folium Rhodoneæ. Quod erat, &c.

COROLLARIA.

I. Ob æquales arcus E M, E D fit A E medius Arithmeticus inter A M, A D, qui intercipiunt æquales ramos Rhodoneæ; ideoque horum ſumma illius duplum adæquat, ſive æquatur toti A E P arcui ſectoris circumſcribentis unum Rhodoneæ folium.

II. Hinc etiam arcus M P æquatur A D.

III. Et eorundem arcuum A M, A D ſumma ad ſemiperipheriam A N K eſt in data ratione *a* ad *b*, quam habet A E ad quadrantem A F.

IV. Et ſector A P C Rhodoneæ circumſcriptus, eſt ad ſemicirculum in eadem data ratione *a* ad *b*, quam habet arcus A P, ſive ſumma duorum A M, A D ad ſemiperipheriam A N K.

PROPOSITIO III.

Numerus foliorum, quibus integra Rhodonea ſimplex compingitur, eſt ad unitatem, ut 2 *b* ad *a*.

Tot enim folia emergunt ex hac deſcriptione, quot ſectores unicuique folio circumſcripti, intra circulum diſponi poſſunt; ſed quilibet ſector eſt ad ſemicirculum, ex *Coroll.* 3. *præced.* ut *a* ad *b*, adeoque ad circulum ut *a* ad 2 *b*, quare numerus foliorum in una circulatione eſt ad unitatem ut 2 *b* ad *a*. Quod erat, &c.

COROLLARIA.

I. Hinc Rhodoneam ſimplicem deſcribere poſſumus, quæ datum foliorum numerum *m*, puta ſex, complectatur, ſi nempe pro ratione *a* ad *b* aſſumatur ratio 1 ad $\frac{m}{2}$ (in caſu propoſito 1 ad 3) quomodo erit 2 *b* ad *a*, ut *m* ad 1 (in propoſito ut 6 ad 1) adeoque prodibit datus foliorum numerus *m*.

II. Sed & Rhodoneam duplicem, triplicem, quadruplicem, &c. eadem arte componemus, dato foliorum numero in ſe recurrentem, ſi nimirum pro Rhodonea duplici

duplici ſumatur ratio 1 ad $\frac{m}{4}$, exiſtente dato numero m impari, alias prodiret Rhodonea ſimplex ſubduplo foliorum numero, quæ in ſecunda circulatione ſibimet ſuperponeretur, per eadem foliorum veſtigia recurrens.

Pro Rhodonea triplici ratio 1 ad $\frac{m}{6}$, dummodo numerus m non ſit per 3 diviſibilis, alias iterum ſimplex Rhodonea prodiret ſubtriplo foliorum numero contenta. Similiter pro quadruplici Rhodonea ratio 1 ad $\frac{m}{8}$ inſerviet, dumodo numerus m ſit impar, alias Rhodonea ſimplex, aut duplex, ut antea oriretur; oportet enim in prima circulatione reſpectu Rhodoneæ duplicis haberi integrum aliquem foliorum numerum cum $\frac{1}{2}$ alterius folii, reſpectu triplicis cum $\frac{1}{3}$, vel $\frac{2}{3}$ folii, reſpectu quadruplicis cum $\frac{1}{4}$, vel $\frac{3}{4}$ alterius folii atque ita pariformiter in aliis.

PROPOSITIO IV.

Si ratio a ad b non ſit numeris effabilis, ſed arcus D A, G A ſint incommenſurabiles, innumera folia ſibimet per infinitas circulationes advoluta circumponentur.

Quælibet enim circulatio, præter certum foliorum integrorum numerum, partem folii ſuo toti incommenſurabilem comprehendet, nec unquam ad idem punctum deſcriptio revertetur, adeò ut æquatio ejuſmodi curvæ infinitorum ſit graduum. (*Vid. Fig.* 5.)

PROPOSITIO V.

At ſi ratio a ad b fuerit dupla, prodibit Rhodonea unifolia.

Nam

Nam ex *Prop.* 4. multitudo foliorum eſt ad unitatem ut 2 *b* ad *a*; ſed in hoc caſu *a* eſt 2, & *b* eſt 1, quare multitudo foliorum eſt ad unitatem ut 2 ad 2, ſive ut 1 ad 1; adeoque numerus foliorum eſt unitas. Et ſane arcus E A, qui ſit ad quadrantem A F ut *a* ad *b*, nempe in ratione dupla, eſt ſemiperipheria, adeoque ſemicirculus eſt ſector A F E circumſcriptus ſemifolio, cujus axis E C ex *Prop. prima*, ideoque integro folio circulus integer circumſcribitur.

COROLLARIA.

I. Facilis eſt hujuſmodi Rhodoneæ unifoliæ deſcriptio, ſi ſuper radio E C deſcribatur ſemicirculus, & ducta chorda E S D, in radio C D ponatur C I æqualis intervallo C S; nam cum C S ſit ſinus anguli C E S ad radium C E computatus, ejuſque anguli duplus ſit A C D, erit ramus C I ad Rhodoneam rationis duplæ, juxta geneſim præmiſſam.

II. Unde etiam, ſi centro C, quolibet intervallo C S, in dicto ſemicirculo arcus P S deſcribatur, & tantundem extendatur in I, ut ſint arcus P S, S I æquales, erit punctum I ad Rhodoneam; quippe C S perpendicularis chordæ E D bifariam ſecat in præcedenti deſcriptione angulum E C D; cumque ſit C M æqualis C S, punctum I eſt in arcu circulari, centro C per I, & S tranſeunte, qui continuatus in P remanet bifariam ſectus in S.

III. Et hinc patet, hanc Rhodoneam duplam eſſe circuli ſuper diametro E C deſcripti, ob quoſlibet arcus I S P duplos ipſorum S P, indeque dimidiam circumſcripti circuli, cujus diameter E A; id, quod conſonat infra generaliter demonſtrandis *Prop. octava.*

PROPOSITIO VI.

Ubi ratio *a* ad *b* eſt æqualitatis, efficitur Rhodonea bifolia, quæ nihil aliud eſt, quàm duplex circulus ſubduplæ diametri ad diametrum circuli, qui Rhodoneæ circumſcribitur. (*Vid. Fig.* 9.)

Nam ratio 2 *b* ad *a* erit ratio dupla, ergo ex *Prop. quarta* multitudo foliorum dupla erit unitatis: & ſane deſcripto circa radium F C, velut diametrum, ſemicirculo, quoniam ramus Rhodoneæ C I debet in hoc caſu æquari ſinui ipſiuſmet arcus A D, utique punctum I ad peripheriam dicti ſemircirculi pertinget, adeoque duplex circulus, circa radios F C, C V, velut diametros, deſcriptus, erit locus talium ramorum, id eſt, Rhodoneam ipſam bifoliam conſtituet.

COROLLARIUM.

Etiam hic conſtat Rhodoneam bifoliam dimidiam eſſe circuli circumſcripti, atque adeo æqualem unifoliæ Rhodoneæ præcedentis propoſitionis.

PROPOSITIO VII.

Quodlibet folium Rhodoneæ eſt ad quadrantem circularem ut *a* ad *b*.

Ductis enim radiis infinitè proximis C I D, C *i d*, & ductis ſinubus G H, *g h* correſpondentibus, nempe æquantibus (*Vid. Fig.* 10, *&* 11.) ramos interceptos C I, C *i*, deſcriptoque concentrico arcu I R, patet fore elementum C I *i* ſemifolii Rhodoneæ ad elementum G H *h g* quadrantis, ut $\frac{1}{2}$ arcus I R ad H *h*, eo quod baſes C *i*, *g h* trianguli elementaris C *i* I, & rectanguli elementaris *g h* H G æquentur; ergo duplum ipſius C I *i* ad G H

h g

h g eſt ut integra R I ad H *h*, nempe in ratione compoſita ex R I ad D *d*, & D *d* ad G *g*, & G *g* ad H *h*; ſed quia G *g* ad H *h* (ex theoria infinitè parvorum) eſt ut radius C *g* ad ſinum *g h*, nempe ut C D ad C I, vel D *d* ad R I, ratio G *g* ad H *h* elidit æqualem ſibi reciprocam R I ad D *d*; quare ſupereſt, ut ratio R I ad H *h* eadem ſit, quæ D *d* ad G *g*; ſed hæc eadem eſt quæ *a* ad *b*, cum in tali ratione ſint, tam A D ad A G, quam A *d* ad A *g*, adeoque & reſidua eandem rationem ſervent; ergo R I ad H *b*, ſive duplum elementare ſpatium C I *i* ad elementum quadrantis G H *b g*, eſt in dicta ratione *a* ad *b*, & hoc ſemper; igitur duplum ſemifolii C I E, nempe integrum folium Rhodoneæ, eſt ad quadrantem, ut *a* ad *b*; Quod erat, *&c.*

COROLLARIA.

I. Hinc ſemifolium C I E ad quadrantem eſt ut $\frac{1}{2}$ *a* ad *b*, (ſive ut *a* ad 2 *b*.

Item ſegmentum Rhodoneæ C I *i* ad ſemiſegmentum circuli A *g h* eſt in eadem ratione *a* ad 2 *b*.

PROPOSITIO VIII.

Quodlibet folium Rhodoneæ medietas eſt ſectoris circularis ſibi circumſcripti, & integra Rhodonea ſimplex medietas circuli, duplex duorum, triplex trium circulorum, &c.

Nam ex *præcedente* quodlibet folium eſt ad quadrantem ut *a* ad *b*, ideoque ad ſemicirculum ut *a* ad 2 *b*, ſed ex *Coroll.* 4. *Prop.* 2. ſemicirculus ad ſectorem folio circumſcriptum eſt ut *b* ad *a*; ergo ex æquo perturbatè quodlibet folium eſt ad circumſcriptum ſectorem, ut *b* ad 2 *b*, ſcilicet in ratione ſubdupla; quare & omnia folia

folia Rhodoneæ ad omnes circumſcriptos ſectores, id eſt Rhodonea ſimplex ad circulum, duplex ad duos circulos, triplex ad tres, &c. in eadem ſubdupla ratione erit.

Aliter. Numerus foliorum ex *Prop.* 3, eſt ad unitatem, ideoque Rhodonea ipſa ad unum folium (ſi eſt ſimplex) ut 2 *b* ad *a*; ſed folium eſt ad quadrantem circuli, *ex præc.* ut *a* ad *b*, ergo Rhodonea ſimplex eſt ad quadrantem circuli ut 2 *b* ad *b*, ſcilicet in ratione dupla; quare ſimplex Rhodonea æquatur ſemicirculo. Similis diſcurſus Rhodoneis duplicibus, & triplicibus applicari poteſt; nam in illis numerus foliorum eſt ad unitatem ut 4 *b* ad *a*, in his verò ut 6 *b* ad *a*, &c.

COROLLARIA.

I. Quælibet Rhodonea ſimplex cuilibet ſimplici Rhodoneæ eidem circulo inſcriptæ æqualis eſt, quocunque foliorum numero conſtet, ſemper enim æqualis eſt ſpatio ejuſdem ſemicirculi.

II. Item quælibet Rhodonea duplex cuilibet duplici, & quælibet triplex cuivis triplici æqualis eſt, ob eandem rationem; quippe illa ſpecies eſt ſemper circulo æqualis, hæc ſeſquicirculo; & ſic de aliis. Oportet autem in duplici, aut triplici Rhodonea computare ſpatia foliorum, quæ ſibi ſuperponuntur, tanquam diſtincta eſſent.

PROPOSITIO IX.

Bifariam ſecto angulo E C A, quem axis folii Rhodoneæ cum tangente C A continet, per rectam C D, & ramo C I deſcripto arcu circulari I S T, erit lunula T E I quadrabilis, nempe ad quadratum radii, ut *a* ad 4 *b*. (*Vid. Fig.* 12.)

Cùm ſit enim quadrans F A ad A E, ut A G ad A D, qui eſt ipſius A E ſemiſſis, erit A G medietas quadrantis, ergo quadratum radii C G, vel C D, duplum eſt quadrati ſinus G H, ſive rami C I; ideoque ſector S C I ad ſectorem E C D ſimilem, ut 1 ad 2; ſector vero E C D ad F C G eſt ut *a* ad *b*; hæc enim eſt ratio arcuum E D, G F, ut eadem eſt integrorum E A, F A, & ablatorum A D, A G; ergo ex æquo ſector S C I ad ſectorem F C G erit ut *a* ad 2 *b*, nempe ut ſemifolium C I E ad quadrantem F G A C, vel ut ſegmentum Rhodoneæ C I ad ſegmentum A G H, vel ut reſiduum C E I C ad reſiduum F G H C, quare etiam reliquum ſemifolii S E I eſt ad reliquum triangulum C H G, aut tota lunula ad quadratum C H G P, in eadem ratione *a* ad 2 *b*, & ad quadratum radii C G, quod prædicti quadrati eſt duplum, erit ut *a* ad 4 *b*. Quod erat, &c.

COROLLARIA.

I. Cùm numerus foliorum Rhodoneæ ſimplicis ſit ad unitatem, adeoque etiam ſumma omnium lunularum, quas integra peripheria radio C T deſcripta abſcindit, ad unam lunulam T E I, ut 2 *b* ad *a*; ipſa vero lunula ad quadratum radii ut *a* ad 4 *b*, patet eſſe ſummam dictarum lunularum ad quadratum radii ut 2 *b* ad 4 *b*, nempe ſubduplam; hoc eſt ſummam talium lunularum æquare quadratum ipſum G H C P quadranti inſcriptum.

II. Unde ſumma lunularum, ex una Rhodonea per dictam peripheriam abſciſſarum, æquatur ſummæ lunularum ex qualibet alia Rhodonea, quotcunque foliorum fuerit, eidem circulo inſcripta ſimiliter determinatarum.

III. Cum

III. Cùm ejuſdem ſectoris E C A medietas ſit tam ſemifolium E I C, quàm ſector E C D, vel E D A, nec non ſector C S V, fiunt ſegmentum C I æquale trilineo E I D, & ſemilunula E S I trilineo C I V æqualis, quod propterea erit pariter quadrabile, utpote ad triangulum C G H in data ratione *a* ad 2 *b*.

IV. Et ſumma horum trilineorum in qualibet Rhodonea pariter ejuſdem erit quantitatis, utpote ſummæ lunularum ejuſdem, vel cujuſcunque alterius Rhodoneæ ſimplicis eidem circulo inſcriptæ ſemper æqualis.

V. Adeoque ſi illa triangularia foliorum Rhodoneæ interſtitia pro foliis computentur, flos inde totidem foliorum perfectè quadrabilis exurget, ut in *Fig.* 13.

PROPOSITIO X.

Ad quodlibet Rhodoneæ punctum I tangentem ducere.

Factum jam ſit; ductaque ramo I C (*Fig.* 14, 15.) perpendicularis C M, conveniat cum tangente I M in M; & radio C I arcus I R infinitè parvus deſcribatur uſque ad alium ramum C *i* infinitè proximum, ſintque ramis C I, C *i* æquales ſinus G H, *g h*, & circuli tangens G L occurrat diametro in L. Erit ergo I C ad C M ut *i* R ad R I, nempe in ratione compoſita ex *i* R, ſeu *g* O, ad O G (hoc eſt *g h*, vel *i* C, ad *b* L) & O G, ſive H *h*, ad R I (quæ ex *Prop.* 7. eſt eadem rationi *b* ad *a*) quare *i* C ad C M erit in ratione compoſita ex *i* C ad *b* L, & ex *b* ad *a*; ſed eadem ratio *i* C ad C M componitur quoque ex *i* C ad *b* L, & *b* L ad C M; ergo oportet rationem *b* L, ſive H L, ad C M eſſe datam, ſcilicet eam, quæ *b* ad *a*, ideoque ſi fiat, ut *b* ad *a*, ita ſubtangens circuli H L ad

CM ramo CI perpendicularem, juncta MI erit tangens Rhodoneæ in puncto I; Quod erat faciendum.

COROLLARIA.

I. Si fiat ut *a* ad *b*, ita CH ad CN ramo perpendicularem, juncta NI erit curvæ Rhodoneæ normalis; nam quia HL ad CM eſt ut *b* ad *a*, & CH ad CN ut *a* ad *b*, erit HL ad CM ut reciprocè CN ad CH; & ideo rectangulum MCN æquabitur rectangulo LHC, id eſt, quadrato GH, vel quadrato rami CI; ergo juncta NI eſt tangenti MI, ſeu curvæ Rhodoneæ in puncto I, perpendicularis.

II. Patet, tangentes angulorum CIM, & LGH, vel GCA ſemper eſſe in data ratione *a* ad *b*.

PROPOSITIO XI.

Si fiat ut *b* ad *a*, ita radius AC ad CQ, & ſemiaxibus FC, CQ deſcribatur quadrans ellipſis FVQ, erit ejus perimetur æqualis perimetro ſemifolii Rhodoneæ ECI, & partes partibus correſpondentibus. (*Vid. Fig.* 16, *&* 17.)

Erit enim ubique etiam GP ad VP, vel *gp* ad *up* in eadem ratione, quæ eſt AC ad CQ, id eſt, *b* ad *a*; quare & reſidua GO, VX in eadem ratione erunt. Quod ſi infinitè proximæ ſint PG, *pg*, GH, *gh*, & correſpondentes CI, C*i* cum arcu infinitè parvo IR, quoniam IR ad H*h*, vel GO ex *Prop.* 7. eſt ut *a* ad *b*, in qua etiam ratione erit VX ad eandem GO, patet ipſas IR, VX æquales fore; cum ergo & ſint æquales R*i*, VX (ob æqualitatem quarumvis CI, GH, vel TV, nec non C*i*, *gh*, *tu*) patet ſubtenſas quoque I*i*, V*u* æquales futuras. Singula igitur elementa, tum curvæ

væ Rhodoneæ E I C, tum ellipticæ F V Q invicem æquantur; quare & perimeter ſemifolii Rhodoneæ erit quadranti curvæ ellipticæ æqualis, & duo quælibet folia perimetrum habebunt integræ curvæ ellipſeos æqualem; Quod erat, &c.

COROLLARIA.

I. Patet, Rhodoneam eſſe ellipſim quandam contractam; nam ſi confluentibus in centrum C punctis T, *t*, ordinatæ elliptici quadrantis V T, *u t*, in ramos abeant a centro C diductos, quadrans ellipſis in ſemifolium Rhodoneæ contrahetur, eadem curvæ longitudine manente.

II. Hinc iterum patet, Rhodoneam eſſe medietatem ſectoris circularis circumſcripti; eſt enim ſemifolium E I C medietas quadrantis elliptici F V Q C, in quem expanderetur, ſi rami ab eorum centro diſſoluti fierent paralleli, & rectæ C Q perpendiculares; cumque quadrans ellipſis ſit ad quadrantem circularem, ut baſis Q C ad baſim C A, nempe ut *a* ad *b*, in qua etiam ratione eſt ſector E C A ad eundem quadrantem, ex *Prop. prima*, patet, ejuſmodi ſectorem æquari quadranti elliptico, ideoque duplum eſſe inſcripti folii Rhodoneæ.

III. Inſuper colligitur, æquales eſſe foliorum perimetros in Rhodoneis, quarum ratio ſit reciproca, & radii ſuorum circulorum in eadem reciproca ratione ſibi reſpondeant; nam ſi radius C F, vel E C *Figuræ* 17. æquaretur baſi ellipſis C Q *Figuræ* 16, & viciſſim radius C F iſtius æquaret baſim C Q ellipſis alterius *Figuræ*, patet, eandem ellipſim F V utrobique reſultare debere, quippe iiſdem ſemiaxibus deſcriptam, eamque fore utrivis folio iſoperimetram, exiſtente ibi ratione *a* ad *b*,

hic

hìc reciprocè *b* ad *a*. Exempli cauſa, ſi ratio *a* ad *b* ſit ſubdupla, ut juxta *Prop.* 3. hinc proveniat Rhodonea tetrafolia, radio autem ſubduplo (adeoque æquali baſi quadrantis ellipſis iſoperimetræ) viciſſim fiat Rhodonea juxta rationem duplam, quæ ex *Prop.* 5. unifolia evadet, erit hæc iſoperimetra uni folio illius; nam baſis quadrantis elliptici huic reſpondens baſim habebit illius radio æqualem, adeoque eadem curva elliptica utrivis folio æqualis oſtenditur.

IV. Si verò in eodem circulo duæ Rhodoneæ deſcribantur, altera juxta rationem *a* ad *b*, altera juxta reciprocam *b* ad *a*, perimetros ſuarum foliorum habebunt ipſis rationum antecedentibus *a*, & *b* proportionales; nam ſi primæ Rhodoneæ tertia quædam Rhodonea ſimilis deſcriberetur in circulo, ad cujus radium prioris radius eſſet ut *a* ad *b*, eſſet perimetur primæ ad perimetrum tertiæ ſibi ſimilis in ipſa ratione radiorum *a* ad *b*. Verùm perimeter hujus tertiæ, ex *Coroll. præced.* æquaretur perimetro ſecundæ, utpotè reciproca ratione, & juxta reciprocos radios deſcriptæ, ergo perimeter primæ ad perimetrum ſecundæ eſt in eadem ratione *a* ad *b*.

PROPOSITIO XII.

Rhodoneam datæ rationis *a* ad *b* minoris inæqualitatis ex conica ſuperficie ſecare.

Fiat ut *a* ad *b*, ita radius baſis NB ad latus NC coni recti NCK, cujus baſis diametro NK ſit perpendicularis radius BF, (*Vid. Fig.* 18.) qui ſit ad BR ut *b* ad *a*, & circa diametros BR, BF deſcribantur ſemicirculi BLR, BSF, quos ſecet quilibet radius BG in punctis L, S, ſitque GH diametro NK perpendicularis. Si ſuper circulo BLR erecta ſuperficies cylindrica intelligatur ſecare conicam in communi ſectione

CIE, erit hæc (in planum explicata) ipſamet Rhodonea propoſitæ rationis. Nam communes ſectiones cylindricæ illius ſuperficiei cum planis triangulorum CBG, CBF per axem coni CB tranſeuntium, erunt rectæ LI, RE ipſi axi parallelæ, ideoque tam CI, ad BL, quàm CE ad BR erunt ut latus coni ad radium baſis, ſcilicet ut *b* ad *a ex conſtructione*, ſive ut FB ad BR, ſive SB ad BL; adeoque CE æquatur BF, & CI æquatur BS, ſive ſinui GH. Explicata autem ſuperficie conica in planum ſectorem circularem ipſi æqualem, radio CN deſcriptum, ejus angulus planus NCG ſubtendetur eodem arcu NG, ſubtendente in baſi coni angulum NBG; adeoque ut BN ad NC, ſive ut *a* ad *b*, ita erit angulus NCG ad ipſum NBG, cujus ſinui GH, ut vidimus, æquatur ramus CI folii CIE, cujus maximus ramus CE æquat radium BF circuli baſis; quare folium ipſum ad Rhodoneam pertinet in data ratione *a* ad *b* deſcriptam; Quod erat, &c.

COROLLARIA.

I. Cùm ſit etiam CE ad EO, ut CF ad FB, ut *b* ad *a*, ut FB ad BR ſintque CE, FB æquales, itidem æquales erunt BR, EO, & ſemicirculus BLR quarta pars erit ſemicirculi AEP duplum diametrum habentis, ſive erit medietas quadrantis AEO; eſt verò (ex noſtra Appendice de Fornicibus conicis, quam *Vivianeis* ſubjunximus jam inde ab anno 1698) ſuperficies conica ADEC ad ſuam baſim ADEO, ut ſuperficies ſemifolii CIE ad ſuam ichnographiam BLR, nempe in eadem ratione lateris coni ad radium baſis; ergo cum ADEO dupla ſit BLR, & ſuperficies ADEC ipſius ſemifolii CIE dupla erit, ut aliunde ſupra demonſtravimus ſectorem folio circumſcriptum illius duplum eſſe.

II. Cùm

II. Cùm oſtenſum ſit eſſe angulum A C I ad N B G, uti & A C E ad N B F, in data ratione *a* ad *b*, patet etiam in eadem ratione eſſe angulum reliquum I C E ad reliquum S B F, exiſtente (ut probavimus) ramo C I æquali ipſi B S; (*Vid. Fig.* 19.) unde ſi ſemicirculi C S E, in arcus concentricos, centro C deſcriptos, reſoluti, arcus quilibet P S, *p s* dividantur ad puncta I, *i*, ut ſit ſemper P I ad P S, *p i* ad *p s* in data illa ratione *a* ad *b*, erunt puncta I, *i* ſic inventa ad curvam Rhodoneam.

III. Imo etſi ratio *a* ad *b* majoris ſit inæqualitatis, adhuc Rhodoneas ope ſemicirculi deſcribere licebit generalius quam in *Coroll.* 2. *Prop.* 5. ſi arcus P S, *p s* producantur ad puncta I, *i*, ut ſint P I ad P S, *p i* ad *p s* in data ratione *a* ad *b*. Facto enim arcu E A R ad quadrantem E A in eadem ratione, ductoque radio C R, fiet angulus R C E ad A C E, ut angulus I C E ad angulum S C E. adeoque & reliquus *i* C R ad reliquum *s* C A, cujus ſinus æquatur C *s*, ſive C *i*, in eadem ratione erit *a* ad *b*; ideoque puncta I, *i* ſunt ad Rhodoneam datæ rationis.

IV. Et ſi arcus illi P S, *p s* in ſemicirculo deſcripti, tum dividantur in ratione *a* ad *b*, tum augeantur in reciproca ratione *b* ad *a*, curvæ interioris longitudo ad longitudinem exterioris erit ut *a* ad *b*, per *Coroll.* 4. *Prop. præcedentis.*

SCHOLION.

Verùm hæc, pro inſtituto noſtro, circa hujuſmodi curvas delibaſſe ſufficiat: quanquam alia etiam Rhodonearum ſymptomata enucleare in promptu eſſet, uti & alias florum ſpecies diversâ geneſi efformatas exhibere facilè

foret, quorum etiam folia (ut poſtremâ propoſitione folia Rhodonearum circa conicam ſuperficiem advoluta dedimus) circa aliquam conoidalem ſuperficiem convoluta deſcribere poſſemus, & quandam foliorum in calice floris latentium imaginem adumbrare, niſi jam tædio Lectorum parcendum eſſet. Unum hoc admonere non prætermittam, quod ex ultimò propoſita generali foliorum Rhodoneæ deſcriptione ſimpliciſſima ex circulo derivata, ſuſpicari quis non immeritò poſſet etiam prima naturalium foliorum ſtamina, quæ in floris, aut fruticis ſemine latent, non neceſſariò ſimilia eſſe foliis ipſis conſpicuis, & jam germinantibus, ſive adultis; ſicut enim ſi florum, & fruticum folia noſtras Rhodoneas reipſa imitarentur, poſſet quis concipere, illorum prima ſtamina ſeminibus cujuſlibet ſpeciei incluſa ſimpliciſſima circulari figurâ infinitè parvâ circumſcribi, ſed mox peculiari vi cujuſlibet ſingularis ſpeciei, dum germinant, ita determinari ſuccum nutritium, ut dum in longum eorum axis extenditur, per quaſdam undas, ſive gyros, ipſi origini ſui pedunculi, velut centro, circumpoſitos, expandatur, eoſque ſemper in determinata ratione, vel arctiores, vel ampliores, quàm ſi circularis primorum ſtaminum figura retinenda eſſet: quo poſito talis ſpecies foliorum Rhodoneæ, ac talis numerus, & forma exurgeret, qualem ratio illa determinaret. Ita etiamſi alia lege florum, & fruticum frondes natura moliatur, non neceſſe eſt earum figuram, uſque ad ipſa prima earundem ſtamina, ex quibus germinant, obſervari; ſed illa in quibuſlibet unius certæ, ac determinatæ figuræ eſſe poſſet, quæ tantum pro diverſa vi, determinante in ipſis expanſionem ſucci nutritii, in ſingulis ſpeciebus varianda foret, juxta diverſam rationem, quæ per ipſorum ſtaminum fibras dirigeretur. Sed ne extra chorum ſaltemus, hæc Philoſophis innuiſſe ſufficiat.

II. *The remaining Part of the Obſervations and Experiments on the* Sal Catharticum Amarum, *commonly called the* Epſom Salt. *By Mr.* John Brown, *Chymiſt. F. R. S.*

NEAR *Newcaſtle*, their Method is, to receive the Sea Water into their *Reſervoirs* at High-Water, at any Time of the Moon, if there be no Freſh in the River, occaſioned by Rain in the higher Country; and from theſe *Reſervoirs*, without expoſing of it in Beds, as at *Lemington*, they pump it into their boyling Pans, where, evaporating it almoſt to a Pellicle, they fill it up again 8 or 9 Times, and then waſte it with a gentle Heat for the common or Sea Salt. The Liquor, that runs from this Salt, when taken out, and put into proper Veſſels, is what they call the *Bittern*; which if it ſtands ſome time in thoſe Veſſels, a Salt will ſhoot and cryſtalize to the Sides, in Taſte pretty much like Sea Salt, but with a ſhare of Bitterneſs, and ſeems to anſwer to the *Cat-Salt* of the *Lemington* Works, and very probably would ſhoot after the ſame Manner, if they made uſe of the ſame *Apparatus*.

I could not but mention this general and looſe Account of making the common Salt, as neceſſary to introduce the Liquor call'd *Bittern*; which, before Dr. *Hoy* found out an Uſe for it, was always flung away; being ſo different in its Properties from the Brine made Uſe of to produce the Sea Salt, that it would not boil up into a Sea Salt again, and required the niceſt Skill and Attendance of the Operator, to determine the Time when to take out the Sea Salt from the Pans,

before

before the *Bittern* incorporated with it, which would otherwiſe ſpoil the whole Making.

The *Bittern* at *Lemington* (as obſerv'd before) not ſhooting to the Sticks, is carry'd by Channels into Pits made tight with Clay, where it ſtands for ſome Months, and there will ſhoot again: What Liquor remains is boyl'd down, till ſuch Time as it is obſerved to be in a Diſpoſition to cryſtalize, and then is convey'd into wooden Coolers lined with Lead: The Liquor, which will not ſhoot there, is boyl'd down after the ſame Manner, in order for another Cryſtalization. By this Time the Liquor ſeems to have alter'd its Property, and becomes of a very pungent biting Taſte, and, if boyl'd down, will no longer ſhoot into Cryſtals as before, but precipitates, during the Boiling, a ſmall grain'd Salt; and if you, for Experiment-ſake, ſhould continue to boil down the Liquor, ſeparated from this Salt, each Quantity of Salt thus produced, will ſtill be more pungent than the other. If you boil down the whole Quantity of this Liquor, it will produce a Salt, which if expos'd to the Air, will run, *per deliquium*. But as this Salt is not the Buſineſs of our preſent Enquiry, it may probably be the Subject of another Paper. The Liquor, that produces this Salt, is always flung away, wherever the *Sal Catharticum* is made.

This is what, at preſent, I can give no other Name to, than a third Salt produc'd from the Sea Water, differing, in ſome reſpects, as much from the other two, as they differ from one another.

To return to the ſeveral Cryſtalizations, ſuch as mention'd to be ſhot from the *Bittern*; theſe will be of different Sizes, as to their Figures, and hold ſome ſhare of the third Salt but now taken Notice of, which makes them apt to give and diſſolve; nor is their Taſte come yet to that ſimple Bitter of the pure Salt. Theſe therefore are either ſeparately, or altogether, to be flung

into a Copper, with as much common Water as is ſufficient to diſſolve them, and allow of a gentle Evaporation, till ſuch Time as they are again ready to be pour'd into the Coolers in order for Cryſtalization. This generally proves to be the pure *Sal Catharticum*, throughly freed (as far as the Experiments I have try'd can be convincive) from either a Sea Salt, or the third Salt. The Liquor decanted from this Shooting, may be boil'd down again in order for a ſecond Shooting, and after that a third; but as the Liquors from theſe Shootings are boyl'd away more or leſs, ſo you will ſooner or later meet again with the pungent Liquor, which contains the third Salt, as you did in the former Shootings from the *Bittern*, which the pure *Sal Catharticum* is as neceſſarily required to be freed from, as from the common Salt; a Proof of which cannot be better determined than by one of the Experiments to be taken Notice of hereafter (*viz.*) that with the *Ol. Vitriol.* which will certainly ferment with this Salt, if the Sea Salt has not been well ſeparated from it, or if it ſtill holds ſome of the third Salt. And when any of the Cryſtalizations will not ſtand the Teſt of this Experiment, they ought to be diſſolv'd and ſhot again, as before, by which means the pure Salt is to be obtain'd. I do not mention this as a Tryal made uſe of at the Salt-Works, but what I have by Experience found to be true. And the ſame Experiment will ſerve to diſtinguiſh a *Sal Mirabile* made at theſe Works, from that made with *Ol. Vitrioli* and common Salt. The Account they give of it is this. They take any Quantity of coarſer grain'd Cryſtals boyl'd from the *Bittern*, which when diſſolv'd and evaporated, more than they would otherwiſe do for making the *Sal Catharticum*, they throw into a wooden Bowl, with ſome Oil of *Vitriol*, where it ſtands for ten Days, and ſhoots into large Cryſtals,

Cryſtals, tranſparent, and like the *Sal Mirabile*: But as this Salt, by this Method, is not ſufficiently ſatiated with the *Ol. Vitriol.* (if they uſe any) ſo it is eaſily diſcovered by the *Ol. Vitriol.* which will readily ferment with it; whereas it has no Effect on the other *Sal Mirabile* made as above.

By the Aſſiſtance of my ingenious Friend, *Robert Cay*, Eſq; at *Newcaſtle*, I have received the ſeveral Shootings of Salts from their *Bittern*, as alſo ſome of the *Bittern* it ſelf; from each of which I have obtain'd a pure *Sal Catharticum*, as alſo the like kind of third Salt, as mention'd from the *Lemington Bittern*. The Method I took in doing it is agreeable to that I have already mention'd, and many Years ago try'd at the Salt-Works near *Portſmouth*. It is by Mr. *Cay* that I am inform'd, they ſometimes boyl their *Bittern* without letting it ſtand any time to ſhoot of itſelf. The Difference is not very material.

If this Account be intelligible, what the *Sal Catharticum* is will no longer be a Myſtery. And the next Thing worth the enquiring into will be, whether this Salt deſerves the Reflections, that have diſcouraged the Preſcription of it? And why it may not paſs for a Salt as excellent in its Kind, and be of the ſame Nature, and have the ſame Properties, as that produc'd from the *Epſom*, or any other bitter purging Springs.

And in order to prove it to be ſo, I ſhall give a very ſhort Abſtract of what Dr. *Grew* ſays of his Salt, and then obſerve how nearly the two Accounts agree.

The Doctor in his Treatiſe *de Natura Salis Cathartici Amari, Chap.* 2. ſays, that in the Evaporation of any of the bitter Purging Waters, they yield a Cremor at Top, as alſo a Sediment, both together weighing 6, 8, or about 10 Drams, from a Gallon of Water; and that the leſſer Part of this Sediment is, in Subſtance,

the

the ſame with this Cremor; the reſt is all Salt, but conſiſts of two ſorts, one a muriatick Salt, the other which is proper or peculiar to theſe Waters.

In the *Epſom* Water, the muriatick Salt is about a 20th Part of the ſaline Mixture; in the *Dulwich* it is in a greater Proportion, and the ſame in ſeveral others; it is, both in its acrimonious Taſte and Figure of its Cryſtals, not unlike to common Salt. The other Salt is that which he ſays is particular or proper to the purging Waters, and is made by Evaporation and Cryſtalization. In this Preparation, firſt the earthy or plaiſtery Part is to be ſeparated, next the muriatick Salt, and, laſtly, a brown and dark Liquor from the proper Salt of the Waters.

And in the 4th Chapter of the ſame Part, having ſhewn the Difference of the Figure betwixt the Cryſtals of this Salt and thoſe of Alum, he goes on, Neither is there any better Ground to account the purging Salt a Species of common Salt, from which being perfectly freed, it differs as much in Taſte as from Alum. And in the ſame Chapter, he ſays it will appear, the bitter purging Salt, although it hath ſome Qualities in common with other Salts, yet is truly, or ſpecifically different from them all. Thus far Dr. *Grew*.

Now I cannot ſee any Thing in this Account, but what will, *conſideratis conſiderandis*, very well agree with the purging Salt from the Sea Water.

For firſt, there is an earthy or plaiſtery Part contain'd in theſe Waters, and this muſt be ſeparated. The very ſame is in the Sea Water, and is precipitated in the Boiling them down, as has been obſerv'd, and by the Operators is called *Scratch*.

Next there is a muriatick Salt allow'd to be in theſe Waters; in ſome more, in ſome leſs, and this is likewiſe

likewiſe to be ſeparated: The very ſame is done from the Sea Water, though in a vaſtly larger Proportion.

And, laſtly, there is a black and dark Liquor to be ſeparated; tho' this is but a dark Way which the Doctor makes uſe of to expreſs himſelf, it cannot be better explain'd, than by what has been found to be Fact in boiling down the Waters at *Shooters-Hill:* That after ſeveral Shootings of Salts by repeating the Boilings of the Waters, there would, at laſt, remain a Liquor of a deep brown Colour, which would no longer yield a cryſtaliz'd Salt; but if boil'd up dry, would afford a Salt of the ſame Kind with the third Salt already men-tion'd: And this explaining Dr. *Grew*'s black and dark Liquor, helps at the ſame time to prove, in this Article too, that the Sea Water affords the ſame kind of third Salt.

I have try'd ſeveral of the Experiments mention'd by the Doctor, by which he diſtinguiſhes his Salt from other Salts. Such as not affecting the Colour of Syrup of Violets; curdling of Milk when boil'd; in the Figure of its Cryſtals; in its eaſy Diſſolution in the ſame Quantity of Water; in its coagulating with the *Ol. Tartar. per D. L.* in its Calcination, and in the Bitterneſs of its Taſte, as well before as after Calcination, *&c.* and find this Salt, thus ſeparated from the Sea Water, anſwer to all the Tryals. Some few Experiments, that the Doctor has not taken Notice of, I ſhall here ſubjoin, and then leave the Whole to the Opinion of better Judges; Whether there be any ſpecifical Difference between theſe two Salts?

In order to have a Standard for theſe Experiments, I purpoſely got my Friend, Mr. *Hyet*, Apothecary at *Epſom* (whoſe Fidelity I could depend on) to boil me down ſome of their Waters, which he did from the

Well

Well in the Town, and ſent me a ſufficient Quantity of the Salts, to anſwer the Purpoſe I wanted them for.

I procured likewiſe ſome of the firſt Salts from the *Lemington Bittern:* Theſe do not hold ſo much of (what I have already diſtinguiſhed by the Name of) the third Salt, as I find the *Newcaſtle* Salts do. This *Lemington* Salt, I, for Diſtinction ſake, call the *firſt Lemington Salt.*

Part of this I diſſolv'd, and ſhot into pure *Sal Catharticum*, being freed, as well from the Sea Salt, as the third Salt; and this I call the *ſecond Lemington* Salt.

I procured likewiſe from *Newcaſtle* the firſt Salts ſhot from their *Bittern*, which I call the *firſt Newcaſtle* Salt.

Part of theſe I likewiſe diſſolv'd and ſhot, and obtain'd a pure *Sal Catharticum*, and this is what I call the *ſecond Newcaſtle* Salt.

I am obliged to make Uſe of the *Sal Mirabile*, made from the *Ol. Vitriol.* and common Salt, that having been taken for the *Sal Catharticum.*

As alſo common Salt, that having been repreſented as the principal Subſtance of the *Sal Catharticum.*

I took half an Ounce of each of theſe Salts, and diſſolv'd them in about two Ounces of Water to each half Ounce of Salt.

A ſmall Quantity of each Diſſolution I pour'd into as many Glaſſes, and dropt into them all ſome *Butyr. Antimonii.* The Precipitation that follow'd, ſeem'd to be alike in them all; and upon dropping a little *Ol. Vitriol.* into each, what was precipitated being more powerfully attracted by the Oil, the ſeveral Liquors became clear. Theſe are the two only Experiments, in which I found the Conſequences ſo much alike in them all.

In

In the following Experiments, the *Sal Mirabile* is ſufficiently diſtinguiſh'd from all the reſt.

Slices of Gall cut into theſe ſeveral Solutions have no manner of Effect upon any, except that of the *Sal Mirabile*, which is ſoon ting'd of the Colour of Sack, or rather deeper.

Sp. Sal Arm. c. Tart. dropt into the ſeveral Solutions turns them all milky, except that of the *Sal Mirabile*, which keeps its Tranſparency.

The *Sp. Salis Armon. c. calce.* the *Ol. Tart. p. deliq.* the *Tinctura Cottinell in Sp. Vin. fact.* do every one, uſed after the ſame Manner, ſufficiently diſtinguiſh the *Sal Mirabile* from all the reſt.

In the following Experiments, the *Epſom* Salt, the *ſecond Lemington* Salt, and *ſecond Newcaſtle* Salt, agree together, and differ from the common Salt, the *firſt Lemington* Salt, and *firſt Newcaſtle* Salt.

In the ſeveral Solutions I dropt a Solution of Silver in *Aq. Fortis*, from which follow'd theſe Conſequences. The Solution of the *Epſom* Salt, *ſecond Lemington* Salt, and *ſecond Newcaſtle* Salt, became equally milky, before the Precipitation. The Solution of the Sea Salt, and *firſt Newcaſtle* Salt, let the Precipitation paſs without receiving any milky Tinge. The *firſt Lemington* Salt, as holding leſs of the *third* Salt, than the *firſt Newcaſtle* Salt did, took a little milky Tinge. The Precipitation fell nimbly thorough the Solution of the *Sal Mirabile*, leaving it milky.

In the Condition theſe were in, I pour'd ſome *Ol. Tartar. per deliq.* to each of them, on which, after ſome time, a blueiſh Scum aroſe on the Surfaces of the *Epſom* Salt, *ſecond Lemington* Salt, and *ſecond Newcaſtle* Salt: There likewiſe appear'd a little on the *firſt Lemington* Salt, but not any on the reſt.

A Solution of corrosive Sublimate was made in Water, ten Drops of which, mixed with the several Solutions, produced little or no Alteration; but upon dropping in the *Ol. Tartari per deliq.* the following Appearances were produc'd: In the Solution of the *Epsom* Salt, *second Lemington* Salt, and *second Newcastle* Salt, the Precipitations were red; in the Solution of the common Salt, and *first Newcastle* Salt, the Precipitations were white; in the Solution of the *first Lemington* Salt, the Particles precipitated approach'd pretty near the Colour of the three first.

I took some of these several Salts in Substance, and to each of them pour'd a little *Ol. Vitriol.* which is one of the Experiments Dr. *Grew* try'd upon his Salt, and which he says causes a moderate Ebullition, whereby it appears to partake of an alkaline Principle: But without looking for this alkaline Principle from its fermenting with an Acid, (Terms justly exploded by the learned Dr. *Freind* in his *Prælectiones Chymicæ*) I am inclin'd to believe, that the Salt he try'd the Experiment on, had not, according to his own Directions, been thoroughly separated from his muriatick Salt. For this Oil pour'd on the *Epsom* Salt, *second Lemington* Salt, and *second Newcastle* Salt, produc'd no sensible Fermentation. On the Sea Salt it acts with Violence, forcing off its acid Spirit with an insufferable *Gas.* The same Effect in proportion it had on the *first Lemington* Salt, and *first Newcastle* Salt; none at all on the *Sal Mirabile*, as being a Sea Salt already satiated with the Oil.

What I have all along call'd the *third* Salt, answers in most of these Experiments to the Sea Salt, and yet has some Properties exceedingly different from it; to those I have mention'd these may be added; it will not decrepitate

crepitate like Sea Salt; it readily melts, when put in a Crucible in the Fire; and when calcin'd till red-hot, affords a *Calx* equal to, if not ſtronger than a Lime-ſtone, and ferments violently, as well with Water as with *Ol. Vitriol.* This *Calx*, when expos'd to a moiſt Air, will Part of it run *per deliq.* but not ſo ſoon as before Calcination. All theſe Properties differ in every Reſpect from the common Salt, and leave me ſtill in doubt what to call it, as alſo how far Experiments of this Kind may be deem'd concluſive.

III. *A Letter from the Rev. Mr.* James Pound, *Rector of* Wanstead, *F. R. S. to Dr.* Jurin, *Secr. R. S. concerning Observations made with Mr.* Hadley's *Reflecting Telescope.*

IT were to be wish'd, that with the particular Description given in a late Transaction (*Numb.* 376.) of the curious Mechanism of that Catadioptrick Telescope, which was made by Mr. *Hadley*, and by him presented to the *Royal Society*; that most ingenious Gentleman would have communicated also a full Account of what Observations he had made with it, whereby the Publick might at length have been apprized of the Usefulness of an Invention, (worthy of its great Author, Sir *Isaac Newton*) which, perhaps from the vain Attempts made by some of putting it in Practice, hath lain neglected these 50 Years; for it is so long, since it was first published in the *Philosophical Transactions*, *Numb.* 81.

Mr. *Hadley* hath sufficiently convinced us, that this noble Invention doth not consist in bare Theory; and it is to be hoped, that he, or some other such curious and worthy Persons, (who scruple not at a little Pains and Cost) will in a short Time find out a Method, either of preserving the concave Metal from tarnishing, or of clearing it easily when tarnished, or else of making a good concave *Speculum* of Glass quicksilver'd on the Back-part. When a Method for either of these

shall

ſhall be diſcovered, 'tis not to be doubted, but that the old *Dioptrick* Teleſcope will be for the moſt Part laid by, and this *Catoptrick* one will be chiefly in uſe among the practical Aſtronomers; inaſmuch as ſeveral Inconveniencies and Difficulties, which are unavoidable in the Management of the former, eſpecially when long, are in this latter wholly avoided.

It is no ſmall Convenience, that by means of one of theſe reflecting Teleſcopes, whoſe Length exceeds not five Feet, (and which may be managed at a Window within the Houſe) Cœleſtial Objects appear as much magnified, and as diſtinct, as they do through the common Teleſcope, of more than 100 Feet in Length.

Mr. *Bradley*, the *Savilian* Profeſſor of Aſtronomy, and myſelf, have compared Mr. *Hadley*'s Teleſcope (in which the focal Length of the Object Metal is not quite 5 Feet and $\frac{1}{4}$) with the *Hugenian* Teleſcope, the focal Length of whoſe Object Glaſs is 123 Feet: And we find, that the former will bear ſuch a Charge, as to make it magnify the Object as many Times as the latter with its due Charge; and that it repreſents Objects as diſtinct, though not altogether ſo clear and bright; which may be occaſioned partly from the Difference of their Apertures (that of the *Hugenian* being ſomewhat the larger) and partly from ſeveral little Spots in the concave Surface of the Object Metal, which did not admit of a good Poliſh.

Notwithſtanding this Difference in the Brightneſs of the Objects, we were able, with this reflecting Teleſcope, to ſee whatever we have hitherto diſcovered by the *Hugenian*; particularly the Tranſits of *Jupiter*'s Satellites, and their Shades, over the Diſk of *Jupiter*; the black Liſt in *Saturn*'s Ring; and the Edge of the

Shade

Shade of *Saturn* caſt on his Ring, as repreſented by *Fig. A. Plate 2.* of the forementionʼd *Tranſact. Numb. 376.*

We have alſo ſeen with it ſeveral Times the 5 Satellites of *Saturn*; in viewing of which this Teleſcope had the Advantage of the *Hugenian*, at that Time when we compared them; for it being in Summer, and the *Hugenian* Teleſcope being managed without a Tube, the Twilight prevented us from ſeeing in this ſome of thoſe ſmall Objects, which at the ſame Time we could diſcern with the reflecting Teleſcope.

I am, &c.

Ja. Pound.

IV. *Ob*

IV. *Obſervations on the Satellites of* Jupiter *and* Saturn, *made with the ſame Teleſcope. By* John Hadley, *Eſq; F. R. S. Extracted from the Minutes of the* Royal Society, Apr. 6. 1721.

MR. *Hadley* gave the *Society* a Relation of ſome of the moſt remarkable Obſervations, which he had made with his Reflecting Teleſcope, before he preſented it to the *Society*.

In obſerving *Jupiter*'s Satellites he has ſeen diſtinctly the Shadows of the firſt and third Satellites caſt upon the Body of the Planet; Mr. *Folkes* and Dr. *Jurin*, being preſent, affirmed, that Mr. *Hadley* had likewiſe ſhewn them the Shadow of the third Satellite through the ſame Teleſcope.

In obſerving *Saturn* the laſt Spring, at a Time when that Planet was about 15 Days paſt the Oppoſition, he ſaw the Shade of the Planet caſt upon the Ring, and plainly diſcerned the Ring to be diſtinguiſhed into two Parts, by a dark Line, concentric to the Circumference of the Ring. The outer or upper Part of the Ring ſeemed to be narrower than the lower or inner Part, next the Body, and the dark Line, which ſeparated them, was ſtronger next the Body, and fainter on the outer Part towards the upper Edge of the Ring. Within the Ring he diſcerned two Belts, one of which croſs'd *Saturn* cloſe to its inner Edge, and ſeemed like the Shade of the Ring upon the Body of *Saturn*; but when he conſidered the Situation of the Sun, in reſpect

to

to the Ring and *Saturn*, he found that Belt could not arise from such a Cause.

He says, that at Times he has seen with this Telescope three different Satellites of *Saturn*, but could never have the Fortune to see all five.

Aug. 1723. Mr. *Hadley* adds, that he has several Times seen the Shadow of the first, second, and third Satellites of *Jupiter* pass over the Body of that Planet, and that he has seen the first and second appear, as a bright Spot upon the Body of *Jupiter*, and has been able to keep Sight of them there for about a Quarter of an Hour, from the Time of their entring on his Limb.

Jupiter's Satellites have of late Years been so situated, with regard to the Earth and *Jupiter*, that he has not had sufficient Opportunity of observing the Transit of the fourth Satellite, or of its Shadow.

The dark Line on the Ring of *Saturn*, parallel to its Circumference, is chiefly visible on the *Ansæ*, or Extremities of the Elliptick Figure, in which the Ring appears; but he has several Times been able to trace it very near, if not quite round; particularly in *May*, 1722, he could discern it without the Northern Limb of *Saturn*, in that Part of the Ring, that appeared beyond the Globe of the Planet. The Globe of *Saturn* (at least towards its Limb) reflects less Light than the inner Part of the Ring, and he has sometimes distinguish'd it from the Ring by the Difference of Colour.

The dusky Line, which in 1720 he observed to accompany the inner Edge of the Ring cross the Disk, continues close to the same, though the Breadth of the Ellipse is considerably encreas'd since that Time.

Fig. 1.

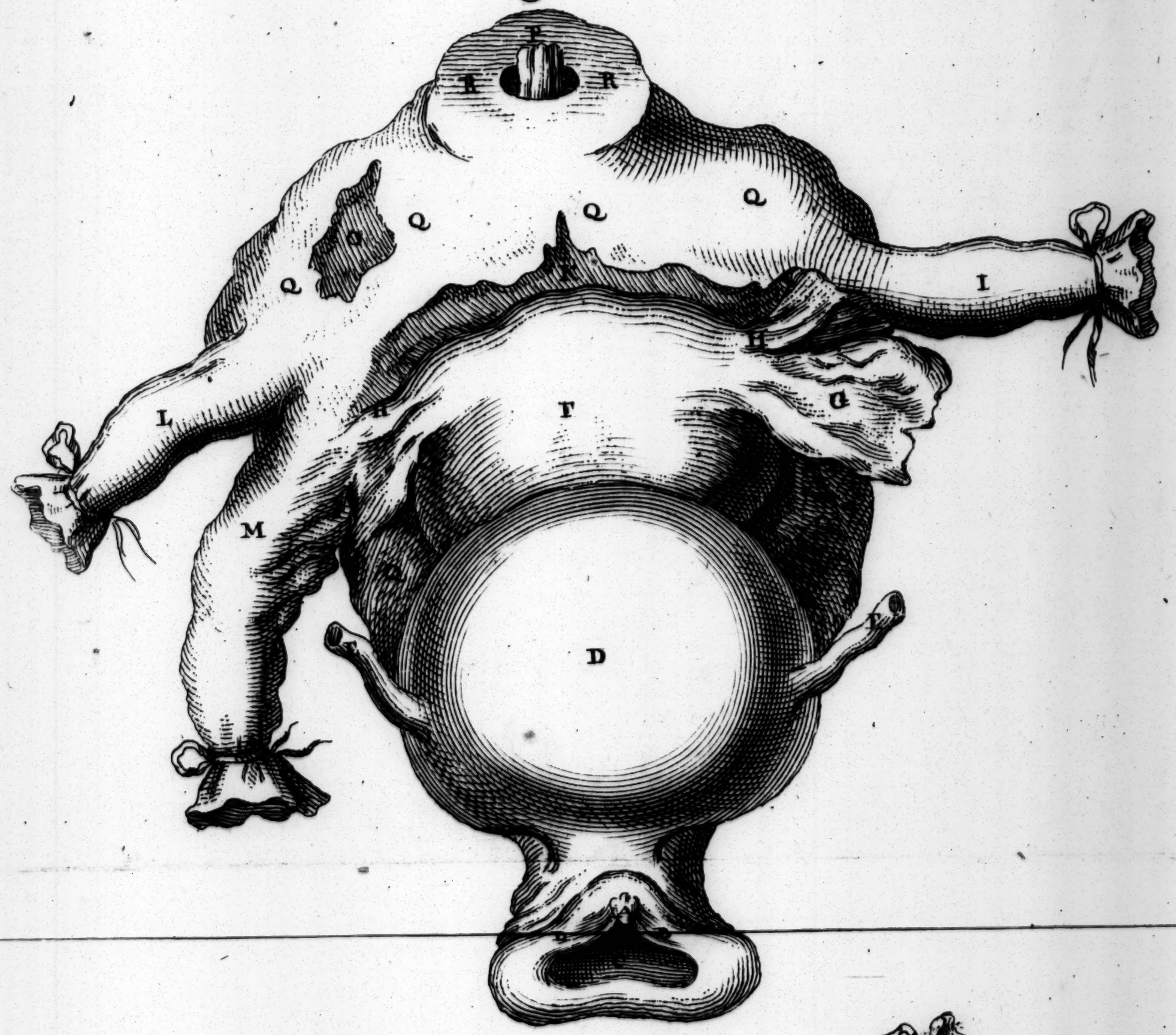


Fig. 2.



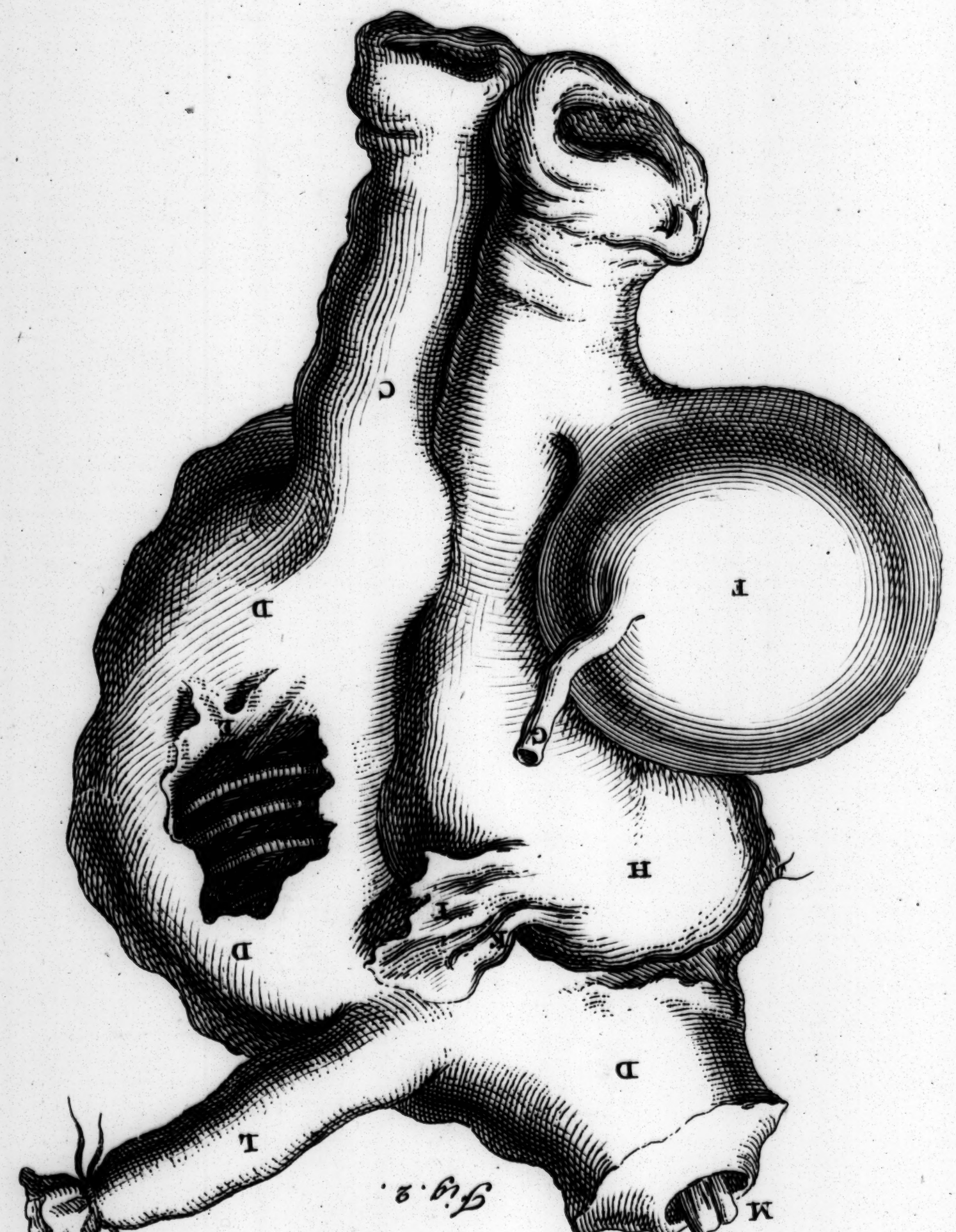
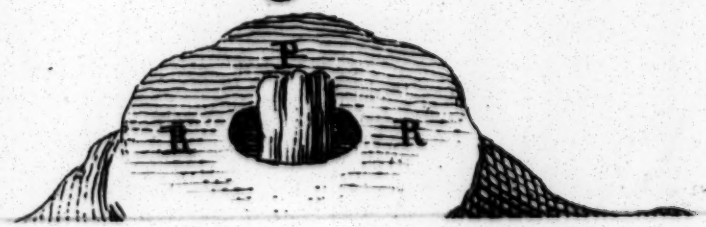


Fig. 2.

Plate II.

Fig. 1.



Philos. Trans. N.° 378.

V. *An Account of an Extra-Uterine Fœtus, taken out of a Woman after Death, that had continued five Years and an half in the Body.* By Robert Houſtoun, *M. D.*

I Was ſent for in *Auguſt* 1717, to a Woman near *Newport-Market*, who had been married eighteen Years to a Native of the *Eaſt Indies*, by whom ſhe had eight Children, beſides two Miſcarriages. At my viſiting her, now, ſhe was with Child in a ſecond Marriage, and her Husband a vigorous young Man.

She was near her full Time, and had felt Pains for ſeveral Days, which, returning by Intervals, ſhe concluded, would, as uſual, bring on her Delivery. Her Mother and her Midwife, apprehending no Difficulty, aſſured thoſe about her, that only Time was wanting.

But I found, on Examination, that her Womb was of no Bulk to contain a Child near its Time; and that its Neck, of an uncommon Hardneſs, was alſo clos'd ſo ſtraitly, as to refuſe the leaſt Admiſſion, even of a ſmall Probe or knitting Needle.

I declared upon this, that her Delivery was impoſſible; becauſe the Child was not within the Womb, but between the Womb and the Guts: That it might be remov'd by a Paſſage to be made for it, without any great Pain, and with Safety to the Mother. I offer'd to undertake it, and aſſur'd them, that this was the only Opportunity; and that if ſhe neglected it, it

would hereafter be out of the Power of Art to give her the Relief, ſhe muſt languiſh for till Death, unleſs favour'd by ſome unlikely and extraordinary Accident.

However confidently I affirm'd it, they liſtened with a Mixture of Disbelief and Amazement, and rejected my Aſſiſtance. At that Time, in Probability, it would have been ſucceſsful; for ſhe was a ſlender well-ſhap'd Woman, in good Habit of Body, and of a ſprightly Diſpoſition.

It was a Year after this, when Mrs. *Hexel*, a noted Midwife in St. *James*'s Pariſh, deſir'd me again to viſit her. I found her much diſorder'd by a growing Impoſthumation in her Belly: I order'd her ſome cordial Stomachicks, *Caſſia*, and ſuch gentle Lenitives; and they met a Succeſs beyond my Expectation: So that, by aid of a regular Diet, and the watchful Exactneſs of a very tender Mother (a Nurſe of above thirty Years Experience about this City) I reſtor'd her to ſuch Strength, that ſhe went chearfully Abroad, and re-apply'd herſelf to Buſineſs. I told her ſhe might frankly benefit herſelf by my Advice, or my Medicines: And ſhe call'd as ſhe found Occaſion.

But about fifteen Months from the Time when I viſited her firſt, her Mother came from her to entreat my Aſſiſtance: She complain'd of great Pain in the lower Part of her *Abdomen*; and I found a Tumour of a conick Form, projecting about an Inch beneath the *Umbilicus*: Its Inflammation, with Tenſion, and a Feveriſhneſs attending it, ſo plainly indicated Suppuratives, that I was not ſurpriz'd to hear, in a few Days, that it had broke, as I wiſh'd.

I propoſed to lay it open, both to give a free Emiſſion, and prevent its becoming fiſtulous; but ſhe was apprehenſive, that I would, as ſhe call'd it, cut open her

her Belly: So that not being able to prevail with her, I order'd a Pot of Unguent, and ſome Plaiſters.

The Ulcer ſoon grew fiſtulous, and ſo continued till ſhe dy'd, which was on the 23d of *March* laſt, in the 41ſt Year of her Age.

For above five Months before her Death, ſhe voided her Excrements by this Vent, and all the ſoft Parts of the *Fœtus*, with ſome ſmall Bones of its Fingers. But the reſt of the *Skeleton* remaining entire, I took it out of her Body, together with the *Vagina*, *Uterus*, *Rectum*, *&c.* wherein it had involv'd itſelf, as may be ſeen more particularly in the Figure annexed.

Explication of the Figures.

Fig. 21.

A The *Clitoris.*
B B The *Nymphæ.*
C The *Rima*, or Entry into the *Vagina.*
D The *Bladder.*
E E The *Ureters* cut off.
F The *Uterus* ſound and entire.
G The Left *Ovarium.*
H H The *Tubes.*
I Part of the *Colon* cut off.
K Part of the *Peritonæum.*
L Part of the *Ileum* cut off.
M Part of the *Cæcum.*
O Part of the *Cranium* that plainly appears.
P The Ulcer, through which the Excrements paſs'd, with ſome ſmall Bones.
Q Q Q Q The *Bulky Maſs*, wherein the *Skeleton* is contain'd, between the *Uterus*, part of the *Vagina*, and *Rectum.*
R R Part of the *Cutis.*

She was full nine Months gone in *Auguſt* 1717, and dy'd the 23d of *March* 1723, on which Day I took it out.

Fig. 22. *A Lateral View.*

A *Orificium Vaginæ.*
B *Anus.*
C *Inteſtinum Rectum.*
DDD The Maſs, wherein the *Skeleton* is contain'd.
E The *Coſtæ* plainly appearing.
F The Bladder laid aſide.
G The *Ureter* cut off.
H The *Uterus.*
I The *Ovary.*
K The *Tube.*
L Part of the *Colon.*
M The *Ulcer*, through which the Excrements paſs'd, about one Inch beneath the Navel.
N Bones in the Orifice of the *Ulcer.*

F I N I S.

E R R A T U M.

Numb. 376. *Pag.* 308. *l.* 7. *del.* ſquare.

L O N D O N: Printed for *W.* and *J. Innys*, Printers to the *Royal Society*; at the *Prince*'s-*Arms*, the Weſt End of St. *Paul*'s Church-Yard.

ADVERTISEMENT.

THE Practice of inoculating the SMALL POX being now extended into many Parts of the Kingdom, and it being highly requisite that the Publick ſhould be faithfully inform'd of the Succeſs of that Method, whether Good or Bad; It is deſir'd, that all PHYSICIANS, SURGEONS, APOTHECARIES, and others therein concern'd, will be pleas'd to tranſmit to Dr. *Jurin*, Secretary to the ROYAL SOCIETY, a particular Account, ſpecifying the Name and Age of every Perſon by them inoculated, the Place where it was done, the Manner of the Operation, whether it took Effect or no, what Sort of Diſtemper it produced, on what Day from Inoculation the Eruption appear'd; and, laſtly, whether the Patient died or recover'd. They are deſired to comprehend in their Accounts all Perſons inoculated by them, from the Beginning of this Practice among us to the End of the preſent Year, and to ſend them ſome Time in *January* or *February* next.

IN caſe this be comply'd with, the ADVERTISER promiſes to give the Publick an exact Account of the whole Number of Perſons inoculated in *Great Britain*, diſtinguiſhing them into Claſſes according to their ſeveral Ages; as likewiſe of thoſe that it has had no Effect upon, and of thoſe that have died of it.

AND he farther promiſes to preſerve the Original Accounts, that ſhall be ſent him, and to give a Sight of them to any Gentleman who ſhall deſire it, that in caſe any of thoſe, who have been inoculated, ſhall afterwards have the SMALL POX in the natural Way, it may be known, whether ſuch Perſon had before received the SMALL POX by Inoculation, or not.

N. B. THE Names of the Perſons inoculated ſhall not be printed without Leave of the Parties concern'd.

Dec. 11th. 1723.

JAMES JURIN.

Numb. 379.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *September* and *October*. 1723.

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Jos: Banks

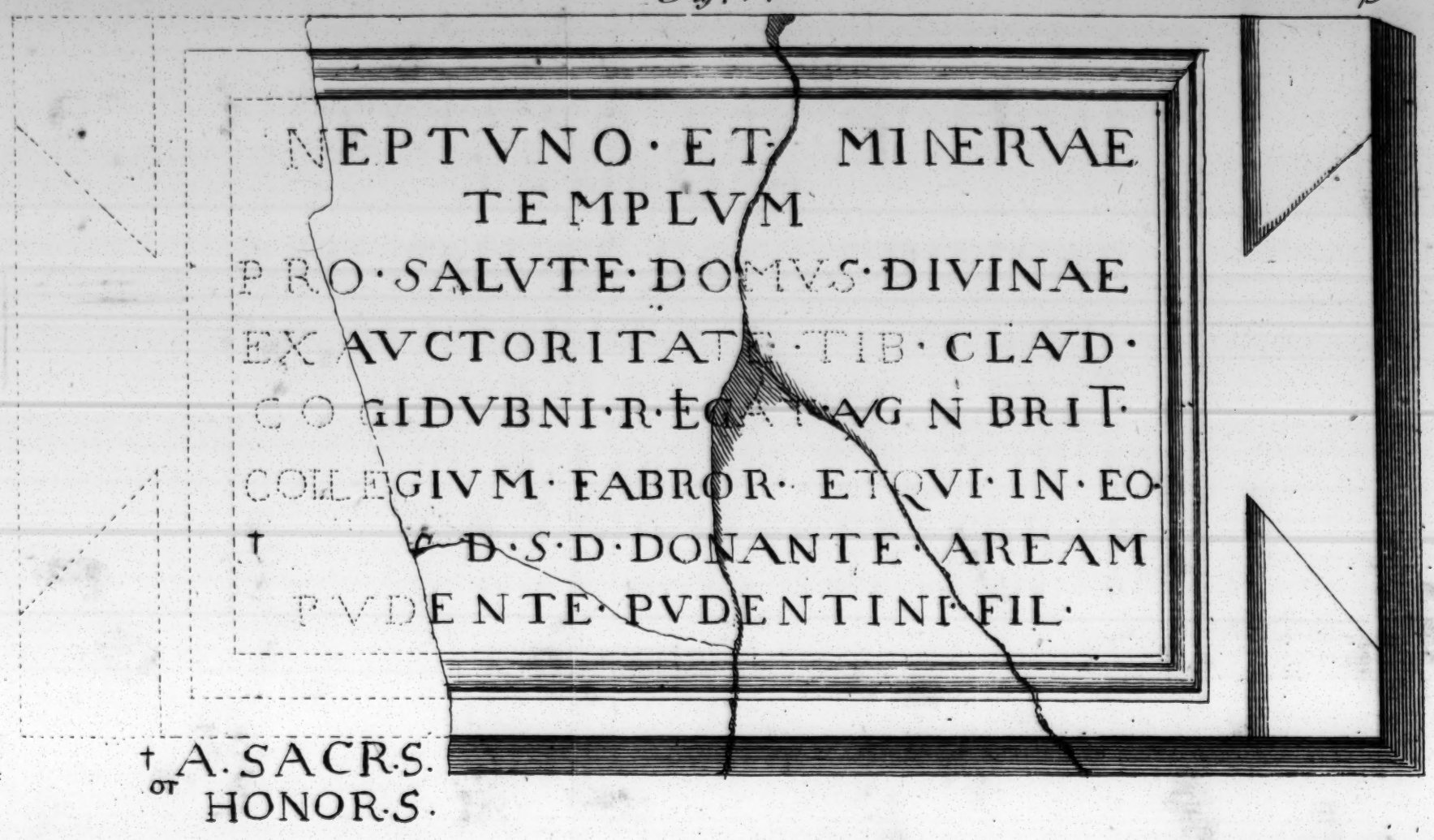
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Fig. 1. Philos. Trans. N.° 379.



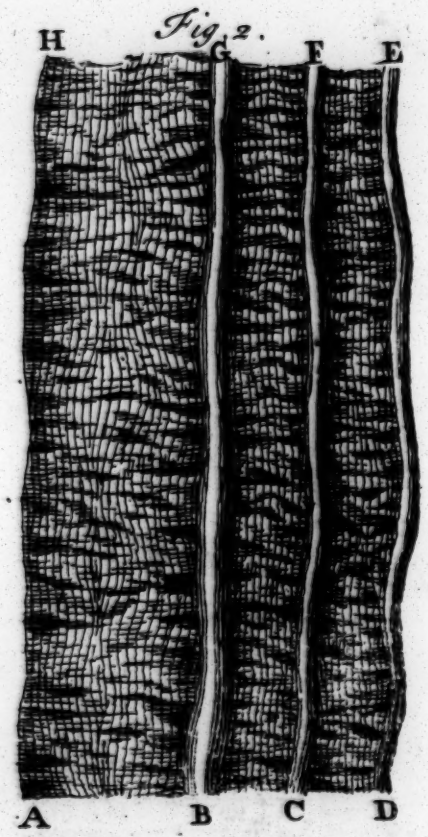


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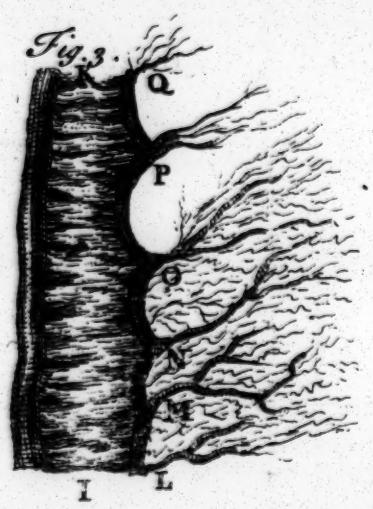


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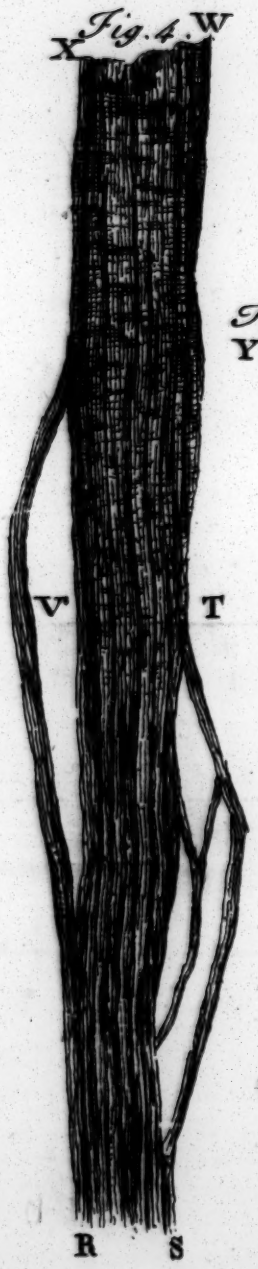


Fig. 4.



Fig. 5.

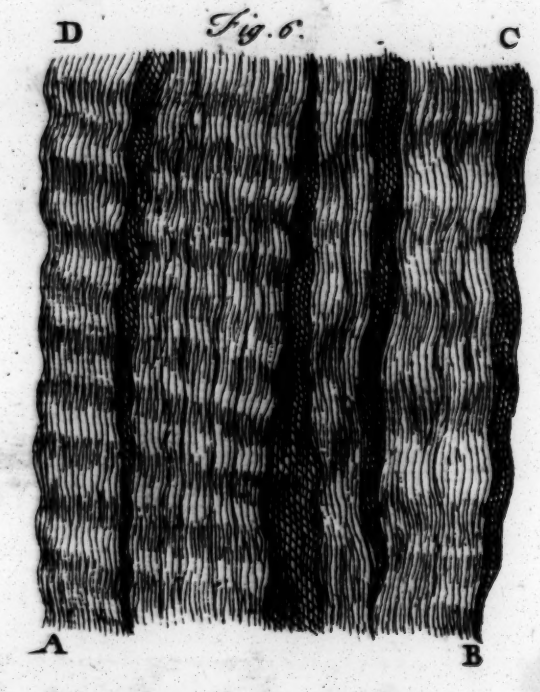


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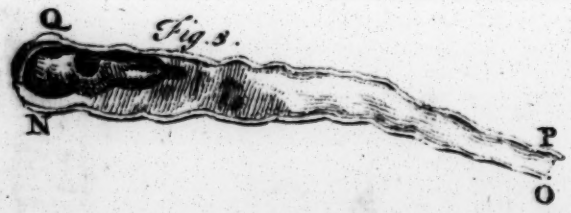


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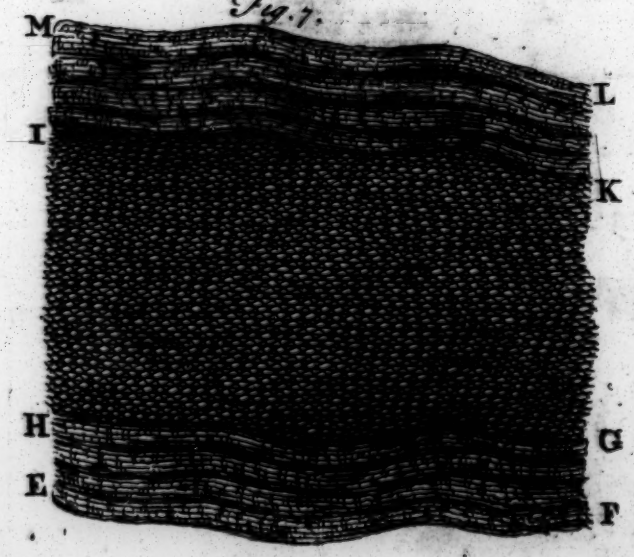
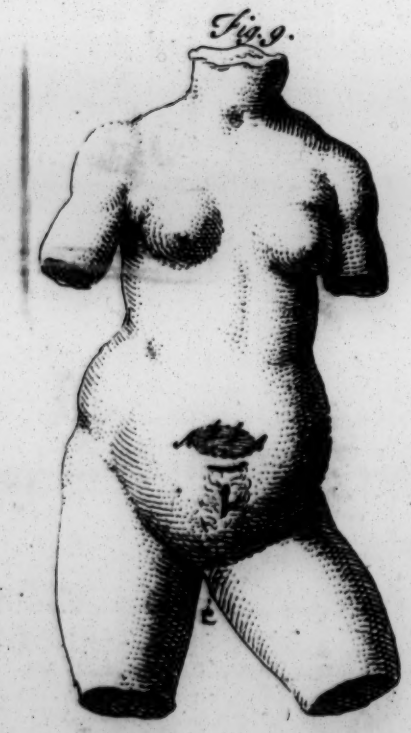


Fig. 7.


Fig. 9.

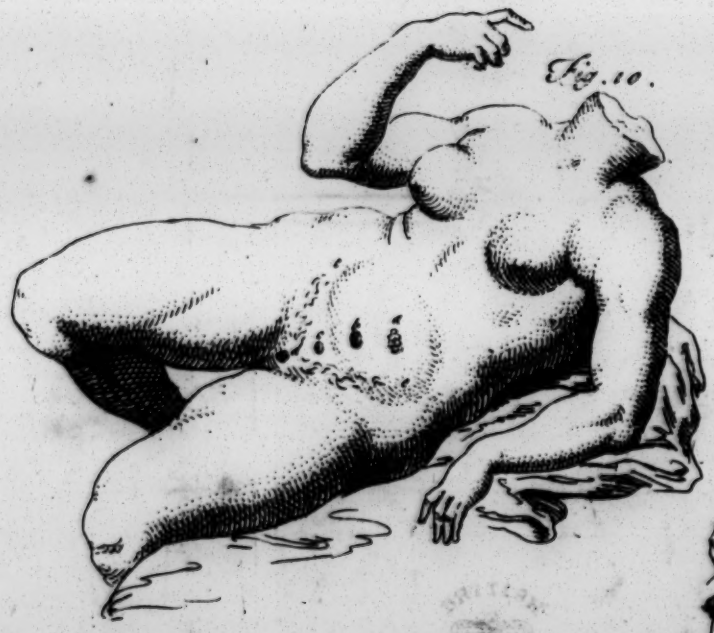

Fig. 10.


Fig. 11.

I. *An Account of a* Roman *Inſcription, found at* Chicheſter. *By* Roger Gale, *Eſq; F. R. S.*

THIS Inſcription, *Fig.* 1. as curious as any that has yet been diſcovered in *Britain*, was found the Beginning of laſt *April* at *Chicheſter*, in digging a Cellar under the Corner-houſe of St. *Martins-lane*, on the North Side as it comes into *North-ſtreet*. It lay about four Foot under Ground, with the Face upwards, by which it had the Misfortune to receive a great deal of Damage from the Picks of the Labourers as they endeavoured to raiſe it; for beſides the defacing of ſeveral Letters, what was here disinterred of the Stone was broke into four Pieces: The other Part of it, ſtill wanting, is, in all Probability, bury'd under the next Houſe, and will not be brought to light till that happens to be rebuilt. The Inſcription is cut upon a grey *Suſſex* Marble, the Length of which was ſix *Roman* Feet, as may be conjectured by meaſuring it from the Middle of the Word TEMPLUM to that End of it which is entire, and is not altogether three Foot *Engliſh*, from the Point mentioned. The Breadth of it is two and $\frac{3}{4}$ of the ſame Feet, the Letters beautifully and exactly drawn, thoſe in the two firſt Lines three Inches long, and the reſt 2 $\frac{1}{4}$.

Being at *Chicheſter* in *September* laſt with Dr. *Stukely*, we took an accurate View of this Marble, which is now fixed in the Wall under a Window within the Houſe where it was found, and that we might be as ſure of the true Reading as poſſible, wherever the Let-

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ters were defaced, we impreſſed a Paper with a wet Sponge into them, and by that Means found thoſe in the fifth Line to have been as we have expreſs'd them above, and not as in other Copies that have been handed about of this Inſcription.

The only Letter wanting in the firſt Line is an N before EPTVNO, and ſo no Difficulty in reading that. As to the ſecond, though it was more uſual in Inſcriptions of this Nature to expreſs the Donation by the Word SACRVM only, referring to the *Temple* or *Altar* dedicated; yet we have ſo many Inſtances in *Gruter*'s *Corpus Inſcriptionum* of TEMPLVM and ARAM alſo cut on the Stones, that there is not the leaſt Occaſion to ſay any Thing farther upon that Point.

The third Line can be no other Way fill'd up, than as I have done it by the prick'd Letters: I muſt own, however, that I have had ſome Scruple about the Phraſe of DOMVS DIVINA, the ſame Thing as DOMVS AVGVSTA, the *Imperial Family*, which I cannot ſay occurs, with any Certainty of the Time it was uſed in, before the Reign of *Antoninus Pius*, from whom, down to *Conſtantine the Great*, it is very frequently met with in Inſcriptions. This kept me ſome Time in Suſpenſe, whether this found at *Chicheſter* could be of ſo early a Date as the Time of *Claudius*: But as we find ſeveral Inſcriptions in *Gruter* with thoſe Words in them, or I. H. D. D. *In honorem Domus Divinæ*, which is much the ſame Thing, without any Mark of the Time when they were cut, they may have been before the Reign of *Antoninus Pius*, and then only came into more general Uſe; and as the Time that *Cogidunus* lived in, will not let this be of a later ſtanding, I think we may offer it as an Authority

for

for the uſe of this Piece of Flattery to the Emperors long before that excellent Prince came to the Purple.

The third Line, as I believe, was EX AVCTORITATE. TIB. CLAVD. and the fourth COGIDVBNI. R. LEG. &c. that is, *Ex Auctoritate Tiberii Claudii Cogidubni Regis, Legati Auguſti in Britannia*; for the following Reaſons: We are informed by *Tacitus in Vita Agricolæ* [a], That after *Britain* had been reduced to a *Roman* Province by the ſucceſsful Arms of *Aulus Plautius*, and *Oſtorius Scapula*, under the Emperor *Claudius*, *Quædam Civitates* Cogiduno Regi *erant donatæ, is ad noſtram uſque memoriam fidiſſimus remanſit, vetere ac jam pridem recepta Populi Romani conſuetudine ut haberet inſtrumenta ſervitutis & Reges.* This *Cogidunus* ſeems to be the ſame Perſon as *Cogidubnus* in our Inſcription, the Letter B in the third Syllable making little or no Difference in the Word, eſpecially if pronounced ſoft, as it ought to be, like a V conſonant.

It is ſo well known to have been the Cuſtom of the Roman *Liberti* and *Clientes*, to take the Names of their Patrons and Benefactors, that it would be waſting of Time to prove the conſtant Uſage of that Practice. Now as this *Cogidubnus*, who, in all Probability, was a petty Prince of that Part of the *Dobuni* which had ſubmitted to *Claudius*, and one that continued many Years faithful to him and the *Romans* [b], had given him the Government of ſome Part of the Iſland by that Emperor, nothing could be more grateful in regard to *Claudius*, nor more honourable to himſelf, after he was *Romaniſed*, than to take the Names of a Benefa-

[a] Cap. 14. [b] V. Tacit. ut ſupra.

ctor to whom he was indebted for his Kingdom, and ſo call himſelf TIBERIVS CLAVDIVS COGIDVBNVS.

I ſuppoſe him to have been a *Regulus* of the *Dobuni*; becauſe we are told by *Dion Caſſius* [c], that *Aulus Plautius* having put to flight *Cataratacus* and *Togodumnus*, Sons of *Cunobelin*, part of the *Boduni* (the ſame People as the *Dobuni*) who were ſubject to the *Catuellani*, ſubmitted to the *Romans*; and the Name *Cogidubnus*, or *Cogiduvnus*, Coc a Dubn, or Dubn [d], ſignifying expreſsly in the *Britiſh* Language PRINCEPS DOBVNORVM, ſeems to put the Matter out of all doubt.

How far his Territories extended, it is impoſſible to define. Biſhop *Stillingfleet* [e] ſuppoſes them to have lain in *Surrey* and *Suſſex*; *Suſſex* certainly was Part ofthem, ſince the Temple mentioned in this Inſcription was erected in it by his Authority; and it is not unlikely, that beſides the *Regni*, who were the People of thoſe two Counties, he might have that Part of the *Dobuni* which had ſubmitted to the *Romans*, and ſeems to have been his own Principality, together with the *Ancalites*, *Bibroci*, and *Segontiaci*, whoſe Countries lay between the *Dobuni* and the *Regni*, beſtowed upon him; the Words *Civitates quædam* in *Tacitus*, not importing no more than ſome *few Towns*, but *ſeveral People*, the Word *Civitas* always ſignifying a *People* in that Hiſtorian.

Before I proceed any farther, it will not be amiſs to obſerve, that *Togodumnus* and *Cogidubnus*, tho' their Names are ſo much alike, were two diſtinct Perſons: The firſt was Son of *Cunobelin*, King of the *Trinobantes*,

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[c] In lib. LX.

[d] V. Baxteri Gloſſar. in verbis COGIDVMNVS. & DOBVNI.

[e] Orig. Britan. p. 63.

tes, vanquiſhed and killed in Battle by *Aulus Plautius*. The ſecond a Prince that ſubmitted to *Oſtorius Scapula*, and continued in his Fidelity to the *Romans*, *in noſtram uſque memoriam*, ſays *Tacitus*, who was born at the latter End of *Claudius*'s Reign; ſo that *Togodumnus* was probably dead before *Cogidubnus* had his Government conferred upon him.

I call it his Government, for tho' by the Letter ·R· ſtanding in the Inſcription with a Point both before and after it, by which it plainly denotes an entire Word of itſelf, it may ſeem that it was intended for COGIDVBNI REGIS, and I believe was ſo in reſpect of his *quondam* Dignity, yet it is evident, that he had condeſcended to take the Title of LEGATVS AVGVSTI IN BRITANNIA from *Claudius*; and that too muſt have been only over thoſe People that he had given him the Government of, *Aulus Plautius*, *Oſtorius Scapula*, *Didius Gallus*, *Avitus Veranius*, and *Suetonius Paullinus*, having the ſupreme Command ſucceſſively about this Time in this Iſland, the ſecond and laſt of which are called expreſsly *Legati* by *Tacitus* [f]. The *Legati Cæſaris* or *Auguſti* were thoſe, *qui Cæſaribus ſubditas regebant Provincias*.

The ſixth Line has loſt at the Beginning the Letters COLLE, but ſo much remains of the Word as makes it to have been indubitably, when entire, COLLEGIVM, and the following Letters are an Abbreviation of FABRORVM.

Theſe Colleges of Artificers were very ancient at *Rome*, as ancient as their ſecond King *Numa Pompilius*, if

[f] Lib. xii. Ann. cap. 32, & Vit. Agric. cap. 15.

if we may believe *Plutarch* [g], who tells us, that the People were divided by him into what we at this Day call *Companies of Tradeſmen*, and mentions the Τέκτονες or *Fabri* among them, tho' *Florus* [h] ſays, that *Populus Romanus a* Servio Tullio *relatus fuit in Cenſum, digeſtus in Claſſes, Curiis atque* Collegiis *diſtributus*. But as the Power of the *Romans* extended itſelf, it carry'd the Arts of that great People along with it, and improv'd the Nations that it ſubdued, by civilizing, and teaching them the Uſe of whatever was neceſſary or advantageous among their Conquerors, from which moſt wiſe and generous Diſpoſition, among other beneficial Inſtitutions, we find theſe *Collegia* to have been eſtabliſhed in every Part of the Empire, from the frequent mention of them in the Inſcriptions collected by *Gruter*, *Spon*, and other Antiquaries.

Several Sorts of Workmen were included under the Name of *Fabri*, particularly all thoſe that were concern'd in any kind of Building, whence we meet with the *Fabri Ferrarii*, *Lignarii*, *Tignarii*, *Materiarii*, *Navales*, and others; the laſt named may have been the Authors of dedicating this Temple to *Neptune*, having ſo near a Relation to the Sea, from which the City of *Chicheſter* is at ſo ſmall a Diſtance, that perhaps that Arm of it which ſtill comes up within two Miles of its Walls, might formerly have waſh'd them. The reſt of the Fraternity might very well pay the ſame Devotion to *Minerva*, the Goddeſs of all Arts and Sciences, and Patroneſs of the *Dædalian* Profeſſion.

As no leſs than five Letters are wanting at the Beginning of the ſixth Line, there cannot be fewer loſt at the Beginning of the ſeventh, where the Stone is more

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[g] In vit. Numæ. [h] Lib. I. cap. 6.

more broke away than above; ſo that probably there were ſix when it was perfect. What we have left of them is only the Top of an S; I will not therefore take upon me to affirm any Thing as to the reading of them, which is ſo entirely defaced; perhaps it was A. SACR. S. *a ſacris ſunt*; perhaps it was HONOR. S. *Honorati ſunt*: As to the former, we find theſe *Collegia* had their *Sacerdotes*, therefore *Qui a ſacris ſunt*, which is found in Inſcriptions [i], would be no improper Term to expreſs them; or it might have been SACER. S. *ſacerdotes ſunt*, ſince we find ſuch mentioned in the following Inſcriptions [k].

MAVORTI SACRVM
HOC SIGNVM
RESTIT-------
COLL. FABR. ARI
CINORVM ANTIQVISS.
VETVSTATE
DILAPSVM ET
REFECER. CVR. L. LVCILIVS
LATINVS PROC. R.P. ARIC.
ET T. SEXTIVS MAGGIVS
SACER. COLL. EIVSD.

Mavorti ſacrum hoc Signum reſtituit Collegium Fabrorum Aricinorum *Antiquiſſimum, vetuſtate dilapſum, et refecerunt. Curabant Lucius Lucilius Latinus, Procurator Reipublicæ Aricinorum, et Titus Sextius Maggius* Sacerdos *Collegii ejuſdem.*

[l] L.

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[i] V. Grut. Corp. XXIX. 8. CXXI. 1. DCXXXII. 1.
[k] Spon. Miſcell. Erud. Antiquit. p. 58.

L. TERTENI AMANTI
SACER. COLL. LOTORVM
IIVIR. C. SARTIVS C. F.
ITERINVS ET L. ALLIVS
PETELINVS D. D.

Lucius Tertenius Amantius Sacerdos *Collegii Lotorum, Dnumviri Caius Sartius, Caii Filius, Iterinus, et Lucius Allius Petelinus Dedicaverunt.*

As to the latter, thoſe Members of the College that had paſſed through the chief Offices of it, as that of *Præfectus*, or *Magiſter quinquennalis*, had the Title of HONORATI conferred upon them: You have ſeveral of theſe HONORATI mentioned in *Gruter*, particularly a long Catalogue of them *in Collegio Fabrorum Tignariorum*, p. CCLXVIII. 1. and in *Reineſius*'s *Syntagma* [m] there is an Inſcription.

EPAGATHO TVRANNO
HONORATO COLLEGI
FABRVM TIGNARIORVM
ROMANENSIVM &c.

So that the Vacuity in our Inſcription may very well have been filled up with one or other of theſe Words, and the three next Letters that follow them D. S. D *de ſuo dedicaverunt*, will agree with either of them, and what precedes them.

The

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[l] Ibid. p. 64. [m] Pag. 605.

The laſt Line has been PVDENTE PVDENTINI FILio; but there muſt have been a Letter or two of the *Prænomen* at the Beginning of it, unleſs it was ſhorter than the reſt at that, as well as at the latter End of it; and from what I have ſaid, the whole may be read as follows.

Neptuno & Minervæ Templum pro Salute Domus Divinæ, ex Auctoritate Tiberii Claudii Cogidubni Regis, Legati Auguſti in Brittanniâ, Collegium Fabrorum, & Qui in eo a Sacris [or] *Honorati ſunt, De ſuo Dedicaverunt, Donante aream Pudente Pudentini Filio.*

Chicheſter, by this Inſcription found at it, muſt have been a Town of Eminence very ſoon after the *Romans* had ſettled here, and in Proceſs of Time ſeems to have been much frequented, by the *Roman* Roads, ſtill viſible, that terminate here from *Portſmouth*, *Midhurſt*, and *Arundel*, tho', what is very ſtrange, we have no *Roman* Name now known for it. I once thought it might have put in its Claim for *Anderida*, which our Antiquaries have not yet agreed to fix any where, being ſituated, very near, both to the *Sylva Anderida*, and the *Southern Coaſt* of the Iſland, the two Properties of that City [n]: But *Henry* of *Huntingdon*, who lived in the Time of *Henry* II. telling us, that the *Saxons* ſo deſtroyed *Andredeceſter*, that *Nunquam poſtea reædificata fuit, & locus tantum quaſi nobiliſſimæ urbis tranſeuntibus oſtenditur deſolatus* [o], it could not be *Chicheſter*; for that was not only rebuilt before his Time, but was a Place of ſuch Note, that when the Biſhops, ſoon after the Conqueſt [p], removed their Churches

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[n] V. Camb. *Brit.* *and* Sonner's *Roman Ports and Forts.*
[o] Pag. 312. V. *Dr.* Tabor's *Diſcourſe of* Anderida. Philoſ. Tranſ. N. 356.
[p] A. D. 1076.

from ſmall decay'd Towns, where ſeveral of them were then ſeated, *in Urbes Celebriores*, *Stigand* then Biſhop of *Selſey* ſettled his Epiſcopal Chair at that Place.

I ſhall conclude with obſerving, that when this Inſcription was dug up, there were alſo two Walls of Stone diſcovered cloſe by it, three Foot thick each, one running North, the other Eaſt, and joining in an Angle, as the *North-ſtreet* and *St. Martins-lane* now turn, which, in all Probability, were Part of the Foundations of the Temple mentioned on the Marble.

Octob. 31. 1723.

II. *De Structura Diaphragmatis. Epiſtola Domini* Antonii van Leeuwenhoek, *R. S. S. ad* Societatem Regiam.

Delphis, 31 *Maii* 1723.

IN epiſtola illa, quam ad Dominum *Jurin* nuper perſcripſi, paucis aperueram opinionem meam de morbo, qui nuperrima hyeme me invaſerat. Statuebam enim malam affectionem Diaphragmatis originem morbo præbuiſſe.

Ut autem de hac Diaphragmatis affectione omnem mihi dubitationem eximerem, Diaphragma ovis anniculæ ad me deferendum curavi; partem illius Diaphragmatis in minuta fruſtula conſectam, ope microſcopii, qua potui diligentia conſideravi; comperique Diaphragma ex parte compoſitum eſſe ex tenuiſſimis fibrillis; quæ ſine microſcopio conſpectæ latum circiter capillum inter ſe diſtant.

Cum

Cum deinde diverſa Diaphragmatis fruſta diverſis microſcopiis applicuiſſem, & viſu diligenter examinaſſem; pro certo ſtatui fibrillas illas ex partibus exoriri carnoſis, quæ Diaphragmati circa coſtas intexuntur. Eaſdem fibrillas Diaphragmati vice tendinum inſervire judicabam. Tendines iſti, ſic mihi dicti, non ſunt per totum Diaphragma æque ſibi vicini: Quin alii aliis, quamvis ſibi vicinis, ſunt aliquanto craſſiores.

Cum autem & fibrillas modo dictas, & membranam inter fibrillas exporrectam, rite conſideraſſem; animadverti Diaphragma, quantum ad maximam ſui partem, ex fibrillis iſtis, & membrana fibrillis interjecta, compoſitum eſſe: Si tamen vaſorum ſanguineorum & copioſi adipis, quæ Diaphragmati magna copia inſident, rationem modo non habeamus.

Membrana vero, inter tendines (ita mihi dictos) interjecta, tot rugulis exiguiſve plicis ſcatebat, ut pene obſtupeſcerem: iſtas autem rugas ſive plicas ad hunc uſum naturaliter deſtinatas eſſe credebam, ut Diaphragma per aëris inſpirationem extenſum rurſus contraherent; eaque ratione opem ſuam conferrent ad aërem, qui Pulmones per inſpirationem impleverat, inde expellendum.

Ut Diaphragmatis contexturam oculis ſpectandum exponerem; exiguam Diaphragmatis ovilli modo dicti portionem delineari, & in icone 2. per ABCDEFGH deſignari curavi. Ubi BG, CF; & DE, tres ſunt tendines, ea magnitudine expreſſi, quam microſcopium oculis exhibebat: qui tendines, ut jam ante monui, magnitudine non parum inter ſe differunt. Inter illos vero tendines membranam interjectam videmus; ex quibus tendinibus, & interjecta membrana, Diaphragma maximam partem compoſitum eſſe modo dicebam.

Ut autem de vera iconis 2 magnitudine judicare poſſitis, delineatorem, ut veram fruſtuli delineati magnitu-

dinem digito indicaret, rogavi; qui mox ſpatium inter Y Z in icone 5. commonſtravit.

Adhæc membranam modo dictam permultis iiſque exiguiſſimis foraminibus pertuſam eſſe obſervavi: quæ exiguiſſima foramina ab abdomine patebant in pectus, & a pectore viciſſim in abdomen. Cum autem fieri non poſſe hactenus judicaverim, ut humor quiſpiam ex pectore delabatur in abdomen, vel ex abdomine ſubvehatur in pectus; nunc ſatius mihi videtur, indicium ſuper ea re meum ſuſpendere. Quin ſic mecum differo; forte etiam pulmonibus noſtris vaſcula inſunt incomprehenſibilis exilitatis. Quippe ſi cogitemus, quantum humoris ex pulmonibus noſtris per exſpirationem educatur in aërem, præ exigua humoris copia quam inſpirando ex aëre inferimus in pulmones; facile in ſententiam illam propendebimus.

Sed & hoc non ſemel obſervavi, quod fibrillas illas, quas tendines appello, vaſa quædam perrepant itinere tranſverſo.

In alio ejuſdem Diaphragmatis fruſtulo, quod microſcopio applicatum ſervabam, clare intueri licebat ſtructuram exortumque membranularum; quas inter fibrillas, ſive tendines ſic mihi dictos, interjacere dixi. Membranulas illas permagno plicarum numero, ut etiam præmonui, inſtructas videmus: quæ omnia in icone 3, exhibentur ad L K. Fibrillæ vero, ſive exigui tendines, de quibus modo differebam, in eadem icone deſignantur per L M N O P Q. Verum fibrillæ iſtæ ſunt hic majores, quam uſpiam mihi occurrerint.

Præterea membranam illam, ex qua Diaphragma maximam partem conſtare dixi, quamvis tam tenuem, a ſe divelli, & exiguam avulſæ partis portionem ope microſcopii in icone 4 exprimendam curavi. Quod eo conſilio feci, ut laceros tendines atque membranulas, quantum

tum ars imitari naturam poterat, oculis ſubjicerem. Ergo hic per R S T V particula indicatur tendinis extenſi: ubi & exiliſſimæ exhibentur fibrillæ, ex quibus prædicta tendinis portio contexta eſt. In eadem icone per V T & W X portio deſignatur tendinis quieſcentis.

Iſtud vero neque explicari, neque ſatis comprehendi poteſt, quam incredibilis fibrillarum, vaſculorum, & particularum numerus hic inter ſe conglomeretur; & ad tenuiſſimæ membranæ, Diaphragmatis inquam, formationem concurrat. Sic autem ſtatuo, quoties validius inſpiramus, omnes illas plicas ſive ſinuoſas corrugationes in Diaphragmate evaneſcere atque complanari: quoties autem exſpiramus, Diaphragma rurſus in plicas rugaſve contrahi, quod & ſuperius notavi.

Dum igitur tantam adipis copiam in Diaphragmate gigni, & congregari videmus; prætereaque cogitamus ſubſtantiam Diaphragmatis per adipem illum ſic utrimque poſſe craſſeſcere, ut in tumorem extuberet; facile intelligemus Diaphragmatis expanſionem atque contractionem ea ratione poſſe impediri atque pigreſcere, atque hinc ſpirandi difficultatem conſequi: ob quam rationem homines obeſos præ aliis anhelos eſſe judicamus. Modico autem adipe Diaphragma perfundi oblinique neceſſarium ſtatuimus: cum enim Diaphragma ſingulis horis nongenties expandi & nongenties contrahi neceſſe ſit; motus illos per adipem magnopere adjuvari cenſemus.

Ceterum frequentiori indagatione explorare conatus ſum, qua ratione carneæ Diaphragmatis partes. quas coſtis vicinas eſſe dixi, tranſiiſſent in membranam; ſive qua ratione membrana Diaphragmatis ex illis eſſet exorta. Verum licet indagationem illam crebro frequentarem, ipſe mihi ſatisfacere non potui.

Jam

Jam & illa dubitatio me ſubierat, an non tendines, quos ego quidem ſic voco, vaſculis ſint inſtructi: Et licet microſcopio meo vix tantum tribuere auderem; tamen tertio poſt die indagationem iteravi, & tendines tranſverſe diſſecui: quando & illuc indagationem meam dirigebam, ut etiam in membrana Diaphragmatis, quam rugoſam eſſe dixi, ſanguinea vaſa requirerem. Tandem igitur ſucceſſit, ut ſanguinea vaſa ſecundum longitudinem tendinum protendi, imo octonos denoſque invicem adjacere viderem. Inde ad membranam, quæ tendines quaſi circumveſtit, oculos converti; in eaque tam ingentem obſervavi numerum exiliſſimorum vaſculorum, ut admiratione defixus hærerem. Complura iſtorum vaſculorum velut areolis incluſa jacebant; quæ tendinum tranſverſe perſectorum vaſcula eſſe cenſebam. Ut autem eorum omnium, quæ modo narravi, teſtem haberem ocularem; microſcopium iſtud, cui dictas Diaphragmatis particulas applicaveram, Chirurgo meo tradidi; qui dicta mea cum iis quæ videbat, examuſſim convenire reſpondit.

Hac tamen obſervatione non contentus, comparavi Diaphragma bovillum; ex quo circa partes illius carneas, quas coſtis adjacere dixi, fruſtum circiter palmarium excidi: comperique Diaphragma bovillum circiter quadruplo craſſius eſſe ovillo; & hanc craſſitudinem maxima ex parte illius adipi acceptam eſſe referendam.

Exinde ex illa Diaphragmatis portione lamellam quam potui tenuiſſimam abſcidi; quoties enim paulo craſſiorem exſcindebam, perſecabam adipem, qui verſus medium Diaphragmatis protenditur; puta, ubi Diaphragma ſatis eſt craſſum, neque adipis expers. Diaphragma vero utrimque, id eſt, ſuperius atque inferius, quatuor diſtinctis conſtat membranis, earumque tendinibus;

tendinibus; qui tendines membranis veluti inclusi delitescunt.

Istorum autem tendinum ingens multitudo non poterat mihi non admirationem parere: neque satis credibile videbatur in corpore, cujus structura functionesque tam parum sunt cognitæ, in Diaphragmate inquam, tales tamque multiplices partes includi.

Ut Diaphragmatis bovilli structuram oculis exponerem, partem illius in icone 6 ad A B C D exprimendam curavi, ubi primo quatuor exhibentur partes distinctorum tendinum, qui magno numero invicem adjacent, & supra in Diaphragmate ovillo etiam sunt exhibiti. Verum per integrum bovis Diaphragma istiusmodi diffunduntur exiguissimi tendines, quos ego quidem sic appello. Et hos quidem tendines, una cum membranis, necesse est in rite constituto corpore sine ulla intermissione alternatim extendi atque contrahi; quæ omnia in icone 6 satis accurate delineator expressit.

Tenuissimas illas fibrillas, uti & membranarum rugulas plicasve, per crebram indagationem etiam ex voto meo deprehendi in Diaphragmate ovillo; nec ipse tantum sæpius cum voluptate consideravi, sed & aliis considerandas exhibui. Ceterum tendines illos, ita mihi dictos, & tenuissimas particulas transverse persecui; inquirere volens num forte sint perviæ, & cavitatibus præditæ. Quando incredibilis exilitatis vascula tanto numero in oculos meos incurrerunt; ut, qui ipse non viderit, vix mihi sit habiturus fidem. Tum & ingentem percepi numerum exiguissimorum vasculorum, quæ transverso Diaphragma itinere permeabant; & quantum ego quidem sentiebam, ad hoc officium a natura destinantur, ut adipem per omnes Diaphragmatis partes circumferant, & ipsi Diaphagmati continuum alimentum subministrent.

Superius modo dixi adipem in Diaphragmate inclusum latere; & utrimque super adipem quatuor exporrigi membranas, inter se omnino distinctas. Addo membranas istas tam arcte sibi conjunctas esse, ut simplex esse membrana videatur.

Jam vero alteri microscopio, quod paulo minus quam microscopia modo dicta magnitudinem objectorum augebat, frustum Diaphragmatis mediocris crassitudinis admoveram. Quod eo spectabat, ut demonstrarem, qua ratione membranæ partes Diaphragmatis adiposas, sive ipsum Diaphragmatis adipem, utrimque circumdent; adeo ut adeps in membranis illis includi videatur. Id autem in icone 7 indicatur per EFGHIKLM, ubi per EFGH, item per IKLM, duæ istæ quadruplices designantur membranæ; in GH vero, & IK, adeps sæpe jam dictus includitur.

Cum deinde tenuissimam Diaphragmatis portionem, quæ præ manibus erat, in orbes conscindere conarer, Diaphragma in duas partes sive lamellas secessit; unde suspicatus sum Diaphragma sic a natura comparatum esse, ut adeps eo facilius per Diaphragmatis substantiam distribuatur.

In icone 7, ubi membranæ transverse sectæ exhibentur, quædam exiguæ apparent corrugationes, quas in iis plerumque percepi. Postea comperi membranulas, in quibus adeps coeundo producitur, exilissimis vasculis annexas esse; quæ tamen vascula per contiguarum partium exsiccationem in Diaphragmate jam dicto erant disrupta. Hanc ego membranularum & vasculorum connexionem ex eo capite necessariam existimo; ne Diaphragma, quoties extenditur, omnino complanetur, sed in cavitatem pene globosam sese expandat.

Forte complures Diaphragma sentient esse membranam apprimè crassam; cum tamen sit membrana perexilis.

exilis. Ut igitur hunc illis errorem eximam; fruſtulum Diaphragmatis bovilli, ſicut ſe nudis oculis offert, delineandum curavi: Iſtud tamen verum eſt, Diaphragma pro tenuitate ſua eſſe oppido robuſtum, quod multitudini exiliſſimorum tendinum, de quibus ſæpius egi, tribuendum eſſe ſtatuo.

Igitur per N O P Q, in icone 8, fruſtulum deſignatur Diaphragmatis bovilli: ubi per fibrillam N O unum latus, ſive dimidia craſſitudo, Diaphragmatis bovilli indicatur; per P Q altera craſſitudinis illius medietas exprimitur. Reliquum Diaphragmatis, nempe quidquid inter O P & N Q intercluſum eſt, adipe ſive partibus adipoſis eſt obſitum: niſi quod inter N Q nonnihil carnis interjaceat, pertinens ad carnem coſtis adjacentem.

Igitur quo morbum antedictum, qui nupera hyeme me corripuit, & quem ego Diaphragmati maxima ex parte imputabam, ſæpius in memoriam revoco; eo etiam ſæpius Medicos errare cogito, dum palpitationem, quam in pectoris regione quandoque percipimus, cordis palpitationem appellant. Certe ego tales palpitationes ex mala Diaphragmatis affectione oriri cenſeo; ſive affectionem illam producat alimenti defectus, ſive vaſorum quorundam efficiat obſtipatio, quæ Diaphragma magno numero pervagantur. Talis enim obſtipatio in ante-dictis tendinibus facile convulſivos motus excitare poteſt; & hanc morbi mei ipſiſſimam fuiſſe cauſam exiſtimo.

III. *Partium Genitalium in Muliere Structura præternaturalis. Ex Epistola Viri Doctissimi* Johannis Huxham, *M. D. ad* Jacobum Jurin, *R. S. Secr.*

Plimutho, v° Kalend. Octob. 1723.

A. B. De parochia *Lanteglaſs* in Comit. *Cornubiæ*, prope *Fowye* oppidum, annos nata XXIII nupta fuit cuidam Nautæ robuſto, tandemque prægnans, ſibi partium male conformatarum conſcia, opem imploravit chirurgicam. Sibi accerſitum eſſe voluit Dominum *Bonnett* de *Fowye* oppido, & artis chirurgicæ, & obſtetriciæ peritiſſimum. Ille vero perſpecto denudato corpore ſequentia obſervavit.

Loco umbilici, in medio abdomine, paululum vero inferius, prominet maſſa quædam ſpongioſa, carnis quaſi offam præ ſe ferens, abdomini tranſverſe incumbens, magnitudinis fere ovi gallinacei, longa autem tres digitos: ex hac duo erumpunt meatus urinarii exiles, qui urinam perpetim exſtillant, quam neque vel retinere vel ejaculare poteſt; hinc veſicam, (ſi quæ adſit) ſphinctere caruiſſe concludendum. Spongioſa hæc molliſque maſſa, urinæ acrimonia corroſa, tactum fere refugit molliſſimum, adeo ut incurvata obambulare coacta ſit, ad dolorem a veſtibus impreſſum evitandum, eamque tenuiſſimis linteis involvere. Hanc quidem maſſam funem fuiſſe umbilicalem male a partu abſciſſum, male dein curatum, exiſtimo; ne vel minima enim umbilici, niſi hic, apparent veſtigia; quid quod & urina per urachum pervium, & in duos

forſan

forſan tubulos diviſum, vel ſaltem per canales duos proprios, effluit. Priori potius credo opinioni; quia dantur Hiſtoriæ urinam per umbilicum in adultis etiam excretam fuiſſe atteſtantes. *Vid. Hiſt. de l'Academie Royale des Sciences, Ann.* 1701.

Hanc infra offam ſubintrat Vaginæ foramen, ab offa diſtans breviſſimo ſpatio: ex hoc effluxere Catamenia, per hoc etiam gravida facta fuit mulier, haud magnam vero tempore coitus percepit voluptatem; ſumma etiam Penis glans in hoc orificium vix fuit intromiſſa, multo minus ipſa virga. In hoc foramen digitum ægre introduxit Chirurgus, eo ſcilicet animo, ut ipſum uteri collum exploraret, quod tamen ne vel tactu percepit, plane autem deprehendit membranam craſſam hocce orificium ab altero inferiore, jam deſcribendo, ſeparantem.

Eo fere ipſo loco, ſuperius vero paululum, ubi in mulieribus rite conformatis adeſt foſſa magna, inventum fuit foramen alterum oblongum, ne vel minimi digiti apicem altius admittens, recto inteſtino, uti poſt partum obſervatum fuit, pervium (quod a ſectione fortaſſe accidit): nullus autem hic occurrit Sphincter: inferius vero rectum inteſtinum, more ſolito, cum Sphinctere circundato terminatur.

Orificium hoc oblongum ab orificio vaginæ, abdomine maxime tumente, duos ſaltem digitos tranverſos diſtitit, inter quæ membrana deſcripta intervenit ab interiore parte, hujuſce vero Fiſſuræ oblongæ quaſi labiorum coalitio exterius e ſuperiore foraminis parte.

Nulla hic Clitoris, hic nulla oſſium Pubis adfuere veſtigia, niſi, quaſi Apophyſes breviores ex utriuſque oſſis Ilii parte inferiore protuberantes, oſſium Pubis rudimenta dixiſſes. Hic fuit ante partum rerum ſtatus.

Die 18 Julii 1722, hora noctis 11ª advocatus eſt *Bonnett* Chirurgus, ut parturienti opem ferret. Perpenſis omnibus, Fœtum invenit Vaginæ orificium infra dilapſum, quem muliere decumbente ſuperiora verſus propellere fruſtra adnixus eſt, ob fortiſſimos Fœtus motus & graviſſimos Matris dolores, cui etiam jam ſupervenere Convulſiones, Syncope, &c. Vaginæ autem orificium vix ac ne vix quidem dilatatum, ita ut illi jam jam moriendum eſſe fuerit omnium expectatio.

In hoc miſerrimo rerum ſtatu, miſericordia & humanitate adductus Chirurgus, poſthabuit omnino, quid vel ignarum vulgus, vel invidus hic garriret aut hic : anceps experiendum eſſe remedium potius quam nullum apud ſe ſtatuit, morte aliter citiſſimo ingruente pede.

Parentibus periculoſiſſimum rerum ſtatum enarravit, nil niſi a ſectione expectandum, ancipitem prædixit eventum. Annuentibus hujus miſerrimæ matre, & aſtantibus, in orificium oblongum inferius ſcalpellum chirurgicum introduxit, & uno ictu coalitionem labiorum hujuſce orificii & membranam ſeparantem diviſit : hinc in unum coivere & orificium Vaginæ & oblongum inferius. Jam digitis facilis introitus, orificium Uteri internum attrectavit ; dilatavit paululum, caput inde ſenſit infantis : quid plura? Fœtus ori intruſo digito, Puellulam vivam, probe formatam, mirantibus maxime aſtantibus, demum extraxit, quæ & adhuc & viget & valet : uti etiam & ipſa Mater, quanquam poſt puerperium febre graviter colluctata eſt.

Jam a partu prolapſu ipſius Uteri divexatur, quo prolabente nec per horas 8, 10ve reducto, eam dein ſi fortius intrudas, exiliunt e meatibus urinariis deſcriptis

tis rivuli duo ad pedis saltem distantiam; argumentum sane Cystidis cujusdam urinam excipientis: aliter revera suspicassem meatus istos duos urinarios ipsorum ureterum fuisse orificia, hic terminantia.

Quaerat fortasse curiosior aliquis, quo forte modo gravida facta fuit muliercula nostra. Illi responderem, Penis intrusionem ad prolem concipiendam haud absolute esse necessariam, feminis autem intra vaginam ejaculationem quam maxime. *Vid. Hist. de l'Acad. Royale des Sciences*, 1712. *Videatur etiam Mauriceau.*

Hujus rei narrationem tibi citius transmisissem, nidiu, frustra autem hactenus, mulieris alteram graviditatem expectassemus, quum per sat longum tempus a puerperio cum marito cohabitaverit.

Figura 9 representat mulierem gravidam.

A A Spongiosam assimulat quasi carnis massam, quam partem fuisse chordæ umbilicalis autumo, magtudinis fere ovi gallinacei, tres vero digitos longam. Ex hac duo erumpunt Fistulæ urinariæ *b b*, quæ urinam perpetim exstillant, nec ex ullo alio orificio redditur urina.

c Orificium Vaginæ, cloacæ galli gallinacei quam simillimum, spisso quasi septo circumdatum: per hoc effluxere ἔμμηνα, per hoc etiam gravida facta fuit mulier. Hoc orificium, dum perpessa fuit mulier graviſſimos partus dolores, nullo fere modo dilatatum fuit, quanquam anus ipse, ob vehementissimos muscularum abdominis, &c. contractiones, maxime hiaret.

d Locum indicat, ubi inventum fuit foramen oblongum, minimi digiti apicem vix admittens. In hoc, tempore puerperii, Chirurgus introduxit scalpellum chirurgicum

cum, idque ab hoc in orificium ſuperius adegit: ita ut jam a partu dehiſcat monſtroſum horrendum informe ingens foramen.

Orificium ſuperius tranſverſum ab inferiore oblongo (appropinquante partu) 2 fere digitos diſtitit. Ex hoc magno hiatu ipſius uteri prolapſum ſæpiſſime nunc patitur. Ex loco etiam, ubi adfuit olim orificium inferius, jam a puerperio, partim excretæ ſunt Fœces alvinæ: hoc vero ante partum minimè obſervatum fuit, ita ut a ſectione forte acciderit.

Orificium hoc oblongum paulo altius quam par eſt, in Figura deſignatur.

e Anum repræſentat paulo magis antrorſum quam in aliis poſitum: per hunc maxima fœcum pars egeritur. Pudendum hoc, quale quale, eſt non denſe crinitum.

IV. *Mulieris*

IV. *Mulieris ejuſdem Hiſtoria, ex Epiſtola Medici Doctiſſimi,* Gulielmi Oliver, *ad* Richardum Mead, *M. D. R. S. & Coll. Med.* Lond. *Soc.*

Vir celeberrime,

TIBI omnium animalium naturas & formationes optimè callenti, acerrimo judicio quotidie perſcrutanti, hiſtoriam inuſitatæ, ac plane mirandæ cujuſdam ſtructuræ partium ingratam non fore, nullus dubito.

Mulierem, Comitatus *Cornubiæ* incolam, in hunc modum, quem jam ſum deſcripturus, a cunabulis formatam fuiſſe, matronæ vicinæ, & non paucis res & nota & examinata fuit, uno ore conſentiunt. Subſtantia quædam carnoſa, ſpongioſa, floride rubeſcens, leviſſimum tactum, ob atrociſſimum dolorem inde oriundum, fugiens umbilici, *v. Fig.* 10. quæ non ex Autopſia ſed ex Chirurgi narratione delineata eſt, naturalem locum uſurpabat, & e cavitate, quæ plerumque ibi eſt, quaſi pullulabat. Ex hac excreſcentia, quæ nec augeri, nec minui, per multos annos ſentiebatur, continuo deſtillabat urina, cui nec alia patuit e corpore via, neque hac potuit vel violentiſſimis nixibus cum impetu expelli, vel per ſaltum excerni, adeo ut paulatim exſudans veſtes interdiu, ſubſtragulaque nocte madefaceret, inquinaret. Paulo infra, ad diſtantiam pæne palmi minoris, orificium quoddam, longitudine unciam unam, latitudine digitum tranſverſum æquans,

ſeſe

ſeſe oſtendebat, ut indicem admitteret, & tamen perſtringeret, ſatis amplum. Hac via effluebant a pubertate menſtrua, unde ad Vaginam & Uterum hunc eſſe aditum facile patebat. Ad eandem fere diſtantiam, qua orificium hoc Vaginæ ab excreſcentia illa diſtabat, patuit & orificium alterum, ſuperiore minus, digitum minimum vix capiens. Huic autem orificio cum inteſtino rectocommunicationem dari, tenuiſſimæ fæcum partes, ex eo frequenter protruſæ, ſatis demonſtrabant. Ab hoc autem Pſeudo-Ano Anus verus, per quem excrementa duriora dejiciuntur, unciis quinque vel ſex extitit, & naturalem fere pudendorum ſitum obtinuit. Pili quidem aderant, ſed rari, nec margines alicujus orificii magis quam reliquorum ornantes, ſed duas lineas deſcribentes, quæ a medio ſpatio inter excreſcentiam illam & commiſſuras femorum cum abdomine incipiebant, & ſibi mutuo appropinquantes angulum, in cujus vertice poſitus eſt verus Anus, conficiebant. Hunc in modum conformata, valetudine ſatis bona fruebatur virgo, & æterna virginitate ex neceſſitate laboraturam concluſerant omnes, quibus res innotuerat. Advenit tandem Nauta quidam, cui æs triplex circa pectus erat; Illam vidit, amavit, duxit, & non multo poſt imprægnavit. Geſtationis tempore optime ſe habuit mulier, quo propemodum finito, de difficultate pariendi, non ſine ratione, aderat gravis ſuſpicio. Orificium Vaginæ a viri congreſſu non omnino dilatabatur, adeo ut de modo imprægnationis multæ inter mulierculas ortæ ſint diſputationes; & aſſeruere aliquæ non ſine dedignatione & horrore, maritum aut viri nomine non eſſe dignum, aut per aliam introiviſſe viam, quod bonus Deus vetet! Immiſſionem autem Penis in Vaginam ad imprægnationem non eſſe abſolute neceſſariam, non eſt quod tibi, Vir clariſſime, cui

hæc omnia optime nota, narrarem. Exemplis turgent libri Medici. Mulier tamen de ſua vita anxia Chirurgos aliquos adivit, conſilium petiit, opem precata eſt. Unus tandem apud *Foy*, oppidum non procul a mulieris noſtræ habitaculo, caſu audito, re perſcrutata, ad promovendum partum, ſi opus fuerit, operam ſuam navare promiſit. Geſtationis tempore perfecte finito, dolores aliaque ſymptomate partum prognoſticantia illam tentaverunt. Chirurgus advocatus aderat. Refert ille infantem conatus ſuos ad regionem pubis, illa ipſa autem ad orificium Vaginæ feciſſe dicit. Quid eſt agendum? Dixit ille inciſione exitum infanti eſſe aperiendum; ex crudeli miſericordia renuunt adſtantes, ingraveſcunt dolores, ſuperveniunt convulſiones, vita deſperabatur. Tandem cum mortem præ foribus eſſe omnes judicaverunt, illam pæne expirantem in manus & poteſtatem Chirurgi tradiderunt. Ille ſtatim diſſectionem iſtius Iſthmi, qui inter orificium Vaginæ & Pſeudo-Anum erat, & haud improprie Perinæum poſſit vocari, inſtituit. Integumentis exterioribus diſſectis, membrana quædam valida & craſſa, tranſverſe locata, ſeſe in conſpectum dedit, quæ Vaginam a canaliculo illo inferiore dividebat. Hac diſſecta iter ad Uterum ſatis amplum patuit, manum introduxit, os Uteri digitis dilatavit, infantem capite prehenſo in lucem tuto eduxit, matrem ad vitam revocavit. Hanc mihi ipſe hiſtoriam retulit, illa ipſa confirmavit. Rei enim novitate percuſſus *Foy* adivi, utrum verum eſſet necne ſciendi gratia. Chirurgum de ſtructura partium originali, & operatione ſua tantum non Cæſarea, ſolicite interrogavi. Omnia, ut ſupra narravi, graphice deſcripſit. Fœminam autem ipſam videndi maxima mihi fuit cupido. Amicum quendam meum, honore ſemper colendum, ut ſub prætextu alicujus negotii mulierem ad domum

ſuam accerſeret, rogavi. Accerſita venit. Deſiderium meum aperui. Illa ab ullo examine, tanquam re omnibus modeſtiæ & virtutis regulis contraria, religioſe abhorrebat. Me Medicum profeſſus, rem tam ab omni immodeſtia alienam eſſe probavi, quod cum in uſum publicum cederet, caſum ſuum communicare ejus eſſe officium demonſtravi. Hac ratiocinandi methodo, & argumenti alterius aurei ope, votum obtinui. Muliere igitur ad examen commode locata, excreſcentiam illam umbilici cavitatem uſurpantem ſuperiori deſcriptioni ad amuſſim reſpondentem inveni. Illam cum ſummo digiti leviſſime tetigerim, miſella, non aliter ac ſi gladio perfoſſa fuiſſet, diſcruciata ejulavit. Mirum ſane mihi videtur hanc mulierem cum marito ſuo poſſe congredi; ex ſitu enim partium nihil aliud cogitare poſſis, quin vir rei Venereæ incumbens, excreſcentiam illam, aliter prorſus intactilem, abdomine ſuo duriter perfricaret. Rogata quomodo hæc perficiebantur, reſpondit ſe omnia ob amorem, quo maritum ſuum proſequebatur, poſſe pati. Sic amor omnia vincit. Sed ad Rem.

Hæc excreſcentia ex multis lobulis, propriis membranis obductis, a ſe mutuo diſtinctis, conflari videtur. In interſtitiis horum lobulorum poruli, per quos ſtillabat urina, oſcula ſua ad ſuperficiem aperiebant. Paulo infra hiatus magnus, ex unione chirurgica duorum orificiorum ad partum facilitandum confectus, ſeſe oſtendebat. Procidentia Uteri tunc temporis laborabat, qui extra labia, ſi circumferentia illa mereatur nomen, propendens, longitudinem ſex unciarum, magnitudinem ovi anſerini æquabat. Tali procidentia ſe ſemper a partu uſque laboraſſe narravit, & quidem mirum eſſet ſi aliter accidiſſet; tanta eſt enim ad orificium Vaginæ apertura, ut nihil poſſit ab

extra

extra Uteri prolapſui obſtare, & Uteri corpus multo magis, quam in ſtatu vulgari, a veſica premitur. Veriſimile enim eſt urinam ad excreſcentiam illam per urachum aſcendere, & per illum ab initio fluxiſſe, quia per meatum urinarium nullum natura præbuit exitum; impoſſibile tamen eſt, ut urina per urachum ad umbilicum aſcenderet, uſque dum veſica ſit turgide repleta; ex illa vero plenitudine neceſſe eſt, ut ſemper in Uterum non parvo pondere gravaretur, & illum foras extruderet. Ut conformatio partium melius appareret, reclinata in lectum Muliere, repoſitionem Uteri tentavi. Non citius illum introducere cæpi, quin urina a preſſione in veſicam repletam facta, per poros excreſcentiæ umbilicalis, multis rivulis, pilum craſſiorem magnitudine non ſuperantibus, cum impetu ad plures pedes proſiliebat, fontem artificialem non injucunde æmulans. Exinanita veſica, Vaginam inverſam in naturalem ſitum facile reſtitui; reſtitutis Vagina, & Utero dehiſcebat chaſma magnum, ex poſitione corporis circulare, cujus diametrum tres pollices tranverſos metiri credo, cujus fimbriæ, potius quam labia, multis ſarcomatis inæqualiter horrebant. In ſuperiore ejus margine interno meatum urinarium fruſtra quæſivi, in inferiore Pſeudo-Anum facile inveni, per quem digitum ſub pubem, quæ ad cartilagineam mollitiem accedere videtur, ad inteſtinum rectum immiſi, necnon contentis ejus turpiter infectum eduxi, unde credo rectum, ad tres pollices ſupra ſphincterem Ani, eſſe perforatum. Paulo ſubtus pubem, ſitum, quo aliarum ſinus ipſe pudoris gaudet, verus Anus hujus fœminæ obtinet, non conſueta caligine & profunditate occultus, utpote non intra clunes poſitus.

Figurarum 10 & 11 *Explicatio.*

Fig. 10.

a Excreſcentia umbilicalis.
b Orificium Vaginæ.
c Pſeudo-Anus.
d Anus.
e e Pili.

Fig. 11.

a Excreſcentia umbilicalis.
b Os Uteri.
c Anus.

G. Oliver.

V. *Fluxus ſanguinis per Penem mirabilis. Ex Epiſtola Viri Doctiſſimi Domini* Howman, *M. D. ad Dominum* Hans Sloane, *Baronettum. Coll. Med.* Lond. *Præſ. R. S. Vice Præſ.*

QUadragenarius quidam civis *Norvicenſis* pancratice valens, profluvio ſanguinis ſinceri per canalem urethræ correptus eſt, 30 die Junii, 1716. Idem rediit phænomenon, 31 Julii. Adhibitis quibuſdam medicamentis, & celebrata venæſectione in Brachio, cohibitus eſt fluxus ſanguinis prædictus, uſque ad octavum diem Septembris, ac deinceps penitus evanuit. Notatu tamen eſt dignum hæmorragias ſupra memoratas abſque omni prævio dolore, ſeu poſtea ſpirituum dejectione contigiſſe.

VI. *An*

VI. *An Account of the Pits for* Fullers-Earth *in* Bedfordſhire; *in a Letter from the Reverend Mr.* B. Holloway, *F. R. S. to Dr.* Woodward, *Pr. Med.* Greſh. *S. R. & Coll. Med.* Lond. *Soc.*

BEDFORD, *6 July*, 1723.

I Went a few Days ago to the *Fullers-Earth* Pits at *Wavendon* near *Woburn*, where there are ſeveral Pits now open; but, as Men were then at work only in one, and I underſtood the Earth was diſpoſed in much the ſame Manner in all, I did not trouble my ſelf to go down into more than that wherein they were then digging; in which I found Things diſpos'd thus.

From the Surface, for about ſix Yards Depth, there are ſeveral Layers of Sands, all reddiſh, but ſome lighter colour'd than others, under which there is a thin *Stratum* of red Sand-ſtone, which they break through; and then for the Depth of about ſeven or eight Yards more, you have Sand again, and after that come to the *Fullers-Earth*; the upper Layer of which, being about a Foot deep, they call the *Cledge*; and this is by the Diggers thrown by as uſeleſs, by reaſon of its too great Mixture with the neighbouring Sand, which covers, and has inſinuated itſelf among it: After which they dig up Earth for Uſe, to the Depth of about eight Feet more, the Matter whereof is diſtinguiſh'd into ſeveral Layers, there being commonly about a Foot and an half between one horizontal

tal Fiſſure and another. Of theſe Layers of *Fullers-Earth*, the upper Half, where the Earth breaks itſelf, is ting'd red, as it ſeems by the running of Water from the ſandy *Strata* above; and this Part they call the *Crop*; betwixt which and the *Cledge* above-mention'd, is a thin Layer of Matter not an Inch in Depth, in Taſte, Colour, and Conſiſtency, not unlike to *Terra Japonica*. The lower half of the Layers of *Fullers-Earth*, they call the *Wall-Earth*; this is unting'd with that red above-mention'd, and ſeems to be the more pure and fitter for *Fulling*; and underneath all is a *Stratum* of white rough Stone, of about two Foot thick, which, if they dig through, as they very ſeldom do, they find Sand again, and then is an End of their Works.

One Thing is obſervable in the Site of this Earth, which is, that it ſeems to have every where a pretty equal horizontal Level; becauſe they ſay, that when the Sand-Ridges at the Surface are higher, the *Fullers-Earth* lies proportionably deeper.

In theſe Works they ſeldom undermine the Ground, but as they dig away the Earth below, others are employ'd to dig and carry off the Surface; otherwiſe, the Matter above, being of ſo light and flitting a Nature, would fall in and endanger the Workmen: For, as was obſerv'd before, that *Stratum* of Sand-Stone, which occurs before they come to the *Fullers-Earth*, does not lie, as in Coal-Pits, immediately over the Matter they dig for, like a Cieling, but even in the midſt of the ſuperjacent *Strata* of Sand, and therefore can be no Security to them if they undermine.

The perpendicular Fiſſures are frequent, and the Earth in the *Strata*, beſides its apparent Diſtinction into Layers, like all other Kinds of Matter, by reaſon

of its peculiar Unctuouſneſs, or the running of the adjacent Sand imperceptibly among it, breaks itſelf into Pieces of all Angles and Sizes.

For the Geographical Situation of theſe Pits, they are digg'd in that Ridge of Sand-Hills by *Woburn*; which near *Oxford* is call'd *Shotover*; on which lies *Newmarket-Heath* by *Cambridge*, and which extends itſelf from Eaſt to Weſt, every where, at about the Diſtance of eight or ten Miles from the *Chiltern* Hills, which in *Cambridgeſhire* are called *Gog-Magog*; in *Bucks*, and *Oxon*, the *Chiltern* Hills, from the chalky Matter, of which they chiefly conſiſt: which two Ridges you always paſs, in going from *London* into the North, North-Eaſt, or North-Weſt Counties in the Manner I before-mention'd: After which you come into that vaſt Vale, which makes the greater Part of the Midland Counties of *Cambridge*, *Bedford*, *Bucks*, *Northampton*, *Oxford*, and *Glouceſter*, and in which are the Rivers *Cam*, *Ouſe*, *Nen*, *Avon*, *Iſis*, and others; which I take Notice of, becauſe it confirms what you ſay of the regular Diſpoſition of the Earth into like *Strata*, or Layers of Matter, commonly through vaſt Tracts, and from whence I make a Queſtion, whether *Fullers-Earth* may not probably be found in other Parts of the ſame Ridge of Sand-Hills, among other like Matter.

VII. *Invi-*

VII. *Invitatio ad Observationes Meteorologicas communi consilio instituendas.* *A* Jacobo Jurin, *M. D. Soc. Reg. Secr. & Colleg. Med.* Lond. *Socio.*

CŒLI & Aeris, quem spiritu ducimus, conditiones varias, frigoris, puta, & caloris, sudi, vel humidi commutationes & vicissitudines, magnas præsertim atque subitaneas, ad Humani Generis valetudinem pertinere merito censetur. Operam itaque & laborem in iisdem observandis minime contemnendum posuerunt non Medici solum, sed & alii quoque ab omni ævo Naturæ rerum contemplandæ studiosi. Superiore tandem sæculo Instrumenta etiam & Machinæ Philosophorum ingenio & diligentiâ repertæ sunt, quibus ponderis, caloris, humiditatis, & elateris aerii momenta & mutationes simul oculis repræsentantur, simul ad mensuram ac trutinam, & quidem subtilem admodum illam atque accuratam, exiguntur.

Nec hic etiam subsistendum judicarunt Eximii illi Viri, sed studio & sciendi amore incitati ad causas harum mutationum, quâ licuit, indagandas contenderunt. Quem in finem Observationes Instrumentorum recens inventorum ope factas de pondere, humiditate, & calore ambientis diligenter in Diariis notabant; iisque multa alia adjiciebant ad Tempestatem ac Cœli faciem, Ventos, & Pluviæ copiam pertinentia, quod in Actis Philosophicis & alibi sparsim videre est.

Methodo

Methodo iſta & obſervandi ratione meliorem facile non reperias. Quod ſi fuiſſent Obſervatores & numero idoneo, & commodis locis per magna terrarum ſpatia diſpoſiti; ac tandem unus aliquis omnium Diaria, quid inter ſe convenirent aut diſcreparent, contuliſſet; profecto jam a multis annis eam haberemus Aeris Hiſtoriam, qualem hoc temporis vix animo & votis fas eſt concipere.

Id etenim compertum habemus, ut quod maxime, ſubitas Tempeſtatum commutationes Ventis præcipue acceptas eſſe referendas; quumque ſcire liceret per talem obſervandi rationem, qualem ſupra expoſuimus, quibus in locis orti, quem curſum, quo tempore, & per quanta terrarum ſpatia Venti tenerent; his cognitis, forſan ad Originem etiam & Cauſas Ventorum aſſequendas via patuiſſet. Unum hoc ſaltem, quod ipſum non leve momentum ad has diſquiſitiones attuliſſet, quodque jam, ut plurimum, pro Conjecturâ veriſimili habetur, potuiſſemus certiſſimis obſervationibus ſive veri, ſive falſi arguere. Opinionem dico ſagaciſſimi Viri, *Edmondi Halleii* *, qui Hydrargyrum ideo cenſet in Barometro aſcendere, quod Venti ex contrariis regionibus utrinque eodem ſpirantes Aerem cogant & quaſi in cumulum attollant; ut contra Hydrargyri deſcenſum Ventis, ex eodem loco verſus oppoſitas partes Aerem deferentibus, & quaſi exhaurientibus, attribuit.

Rogantur itaque Eruditi, qui ad excolendam hanc partem Hiſtoriæ Naturalis operam ſuam conferre voluerint, ut quotidie ſemel minimum, vel utcunque ſæpius libuerit, notare dignentur in Diario Barometri & Thermometri altitudinem, Venti Plagam cum aliquâ virium æſtimatione, Cœli faciem, & Pluviæ vel Nivis

* *V.* Philoſ. Tranſact. N. 181.

quantitatem, quæ tempore poſt obſervationem ſuperiorem elapſo deciderit. Quod ſi quis Obſervationes Hygroſcopii cujuſlibet, ſive Acus Magneticæ ope factas adjicere voluerit, non erit ingratum.

Quoties ingruerit Procella vehementior, utile fuerit ortum ejuſdem, incrementum, ſummam violentiam, remiſſionem & exitum notatis temporibus accuratius deſignare, uti & altitudines Barometri, quæ dictis temporibus reſpondeant.

Monendum cenſemus, ut qui Barometri replendi & conficiendi modum callent, Barometro vulgari, ſive aperto, quod vocant, utantur. Sit autem Tubus quartam, ut minimum, vel etiam tertiam digiti partem latus; quum in Tubis anguſtioribus Hydrargyrus infra juſtam altitudinem ſubſidere deprehendatur †. Ciſternæ vero, ſive Vaſi Hydrargyrum excipienti tribuetur diameter octonis ſaltem, vel decem partibus major Tubi diametro, idque eum in finem, ut aſcendente, vel ſubſidente Hydrargyro in Tubo, altitudo Hydrargyri in Ciſternâ invariata permaneat, aut certe quam paululum immutata.

Qui vero Barometro clauſo, ſive portatili uti malunt, ejuſmodi Barometra magnâ diligentiâ fabricata comparare poterunt apud Laudatum Artificem *Franciſcum Haukſbejum*, in Areâ vulgo dictâ *Crane-Court*, *Londini* degentem; qui Thermometra etiam ſubminiſtrabit ad eam Scalam, ſive graduum notationem exacta, quæ jam per multos annos, exquiſitis ejus Thermometris inſculpta, innotuit Eruditis.

Qui Thermometro utuntur aliâ quâcunque ratione conſtructo, rogatos volumus, ut in Diario Thermometri ſitum, fabricam, diſpoſitionem graduum in Scalâ, & nomen

† *V.* Philoſ. Tranſact. N. 363.

men etiam Opificis, ex cujus Officinâ prodiit, apponere ne graventur. Situm Thermometro commodiſſimum cenſemus in conclavi ad Septentriones obverſo, ubi focus aut nunquam accenditur, aut ſaltem quam rariſſime.

Quo facilius inter ſe conferri poſſint Diaria, commodum fuerit omnia in hujuſmodi formam diſponere.

Columna prima indicet diem & horam obſervationis; ſtylo autem ut omnes Juliano, ſive Vetere, in Diariis utantur, Obſervatores rogamus.

Secunda altitudinem exhibeat, ad quam attollitur Hydrargyrus in Tubo Barometri ſupra ſuperficiem Hydrargyri in Vaſe, per digitos, ſive partes duodecimas Pedis *Londinenſis*, & per partes decimales eorundem digitorum notatam. Habet autem Pes *Londinenſis* ad *Pariſienſem* eam rationem, quæ eſt inter 15 & 16 proxime.

Columna tertia gradum monſtret, & partes gradus decimales, quas Spiritus in Thermometro attingit.

Quarta Venti Plagam & ſpirandi vires repræſentet; quæ vires ſemper denotari poterunt per aliquem ex numeris ſequentibus, 1, 2, 3, 4: ex quibus 1 ſignificet leniſſimum Aeris motum vix arborum folia agitantem, 4 vero ſummam Venti violentiam; numeris 2 & 3 intermedias inter haſce Ventorum vires exponentibus, & denotante cyphrâ, ſive 0, perfectam Malaciam.

Quintam occupet Cœli facies, & ſuccincta Tempeſtatis hiſtoria.

Sexta & ultima altitudinem pluviæ, vel nivis in aquam reſolutæ, quæ poſt ſuperiorem obſervationem deciderit, per digitos *Londinenſes* & eorum partes decimales metiatur.

Hæc facile æſtimari poterit ope Infundibuli duos circiter, vel tres pedes ampli, Vaſis alterius aquam ex Infundibulo defluentem excipientis, & Menſuræ Cylindricæ cum Regulâ in digitos & partes decimales divisâ.

Infundibulum ita ſitum ſit, ut, quicunque ventus flaverit, nulla tamen pluviæ pars ſive ædificii interventu, ſive quocunque alio impedimento intercipi queat. Sit autem vas aquam continens undique probe clauſum, ne quid in vapores attollatur, anguſto ſolum foramine, ad aquam deſuper ex Infundibulo excipiendam, relicto. Menſuræ porro Cylindricæ Diameter decem partibus minor Diametro Infundibuli tribuetur: quo fiet, ut aqua digitum unum alta in menſurâ ad altitudinem centeſimæ partis digiti in Infundibulum, atque adeo in reliquam terram, cecidiſſe intelligatur; & ſimiliter pro partibus digiti decimalibus.

Ad finem vero Menſis & Anni cujuſque apponatur media altitudo menſtrua, vel annua, Barometri & Thermometri, uti etiam ſumma omnium altitudinum Pluviæ, quæ Menſe, vel Anno integro deciderit. Habebitur autem dicta media altitudo, redigendo in unam ſummam, omnes Barometri altitudinum obſervationes manę factas, Thermometri vero ſive matutinas, ſive totíus diei maximas, (quæ nempe circa horam tertiam, vel quartam pomeridianam contingunt) & ſummam iſtam per numerum dierum dividendo.

Omnes rogamus, qui ſupraſcriptas Obſervationes, vel univerſas, vel aliquâ ex parte volent inſtituere, ut Diariorum Exempla, ad finem anni cujuſque continuata, ad Secretarios Regiæ Societatis tranſmittere dignentur; uti cum Diario, quod *Londini* juſſu Societatis Regiæ conficitur, conferri poſſint. Conſilium vero eſt, ut quicquid ex Diariorum iſtorum collatione colligi poterit, ſingulis annis in Actis Philoſophicis cum Publico communicetur.

Diarii

Diarii Forma.

Dies & Hora 1723. Nov. St. V.	Barom. alt. dig. dec	Therm. alt. gr. dec.	Vent.	Tempestas.	Pluvia. dig. dec
1. 8 *a. m.*	29.75	49 . 6	S. W. 1	Cœlum nubibus obduct.	0.035
				Imbres interrupti.	
4 *p. m.*	29.56	47 . 3	S. W. 2	Sol pervices intercurrens	0.043
2. 7 ½ *a. m.*	29.24	48 . 5	S. 1	Pluvia fere perpetua	0.725
3. 9 *a. m.*	29.95	49 . 7	N. 1	Cœlum sudum	0.032
5 *p. m.*	30. 4	49 . 2	N. 1	Cœlum sudum	0.000
4. 7 *a. m.*	29. 9	47 . 0	S. W. 1	Nubes sparsæ	0.000
10	29. 7	46 . 2	S. W. 2	Imbres intercurrentes	0.103
12	29. 4	45 . 0	S. 3	Cœlum nubibus undique fere tectum	0.050
3 *p. m.*	28. 8	46 . 0	S. 4	Nubes sparsæ	0.000
5	28. 6	47 . 2	S. W. 4	Eadem Cœli facies	0.000
7	28. 9	48 . 0	S. W. 2	Pluit	0.000
9	28. 9	48 . 2	0	Pluvia fere perpetua	0.305
5. 7 *a. m.*	29. 7	53 . 4	N.E. 1	Sudum. Gelu.	0.250

VIII. *An*

VIII. *Account of a Book, entitled,* Adverſariorum Anatomico-Medico-Chirurgicorum Decas tertia. *Auctore* Frederico Ruyſch, *M. D. Anatom. & Botan. Prof.* Amſtel. *R. S. Soc.*

§ I. THE learned Author, who has ſo long improv'd the World by his curious Searches into the niceſt Secrets of the Animal-Machine, and illuſtrated them by his admirable Preparations, gives an Account of preternatural Things found in Tumors, of that Sort which we call *Atheroma*, ordinarily a *Cyſt* filled with a thick Matter like Pult; ſuch are Bones, Fleſh, Hair, Teeth, and other Things very ſurprizing and unaccountable. He tells us, he firſt found out the Fabrick of the cortical Part of the Brain; that 'tis made of ſmall pulpy Canals from the Ends of the Arteries: That many Years ago he drew, by ſimple Diſtillation, from crude Vegetables, a perfect volatile Salt; and that 'tis eaſily done from freſh Seeds of the hot antiſcorbutic Herbs, ſuch as Muſtard, Rocket, Onions, *&c.*

§ II. He diſſects a Pear, which he ſays is entirely compos'd of the Pipes in the Stalk, dilated into a ſoft and moiſt Pulp, like what they antiently call'd the *Parenchyma*, that compoſes the Liver and Spleen, which he affirms to be pure Veſſels, not Glands diſtinguiſh'd by being invelop'd with one proper Membrane. You may, if you pleaſe, call the Pear, the Liver and the Spleen, taken in the whole, a Gland; but he denies any particular Glands in their Compoſition.

§ III. He tells a remarkable Story of a Girl, who had frequent Eruptions of Blood from the Skin of her Head, Ears, Mouth, Navel, and the Nipples of her Breaſt:

Breaſt: For fourteen Weeks ſhe eat no Meat, nor had any Excretion by Siege or Urine; and many other odd Symptoms.

§ IV. He gives us a pretty Obſervation of the *Cicatricula*, as commonly call'd, in the *Ovaria* of Females, whence the impregnated Egg is dropt into the *Falloppian* Tubes. He ſhews, that in reality it is a *Calyx*, or natural Aperture, which enlarges itſelf for that Purpoſe by Degrees, and after Excluſion cloſes again, as the *Os Uteri* afterwards; ſo that the Egg truly drops from it, as an Acorn when ripe from its Cup; and the Trace of it ſoon becomes imperceptible. He ſays farther, he has frequently ſeen the thick Part of the Male Sperm carry'd up even into the *Falloppian* Tubes upon Impregnation.

§ V. He ſpeaks of an Obſtruction, that has ſometimes happen'd in the Inteſtines of new-born Infants, ſo that they have had no Manner of Paſſage by Stools, and that gentle Lenitives have not been able to relieve them: In this caſe, he adviſes ſtrong Purgers, adapted to their tender Age.

§ VI. The Author informs us of wonderful Appearances within the very Center of human Bones; for in eight ſeveral Preparations he has, of Leg and Thigh Bones, and others, of Men and Infants, he has obſerved plain *Chryſalis's* of Inſects, and very perfect, of different Sorts, lodged in the Cavities of the Marrow: How they come there, he can no more account for, than for whole Bundles of Worms twiſted together, which he has found in the great Artery juſt by the Heart; or for ſix fat, thick *Erucæ* in a Sheep's Brain; and many of the like Nature, that have happened in the Way of his Obſervation, which are in the Czar's Repoſitory.

In § VII. he ſays, very often, upon Diſſection of the Bodies of old Women, he has found the meſenteric Glands,

Glands, that miniſter to the Conveyance of the Chyle, perfectly waſted away; ſo that he judges it not improbable, that, in ſuch Caſes, the meſaraic Veſſels abſorb the Chyle from the Guts, and carry it into the Blood, at leaſt in part, according to the Notion of the Antients, who knew not the lacteal Veſſels: This he thinks not a little confirm'd by the like waſting of the glandular Part of the Breaſts in old Women, which though formerly very large, ſhall have nothing but the Nipples left.

§ VIII. He treats of the *Epidermis*, or Scarf-Skin, with a good Method of ſeparating it for publick Demonſtrations: He takes off a Piece of the whole Skin, and nails it upon a Board with the Outſide uppermoſt, and then puts it into boiling Water, which raiſes it ſo, that with a blunt Knife it is eaſily ſeparable, which is a much better Way, than that of burning or bliſtering. He ſays, the different Colours of the Skin are owing to the *Corpus Reticulare*, which in Blackmoors is perfectly black, in Moors of a tawny Colour, in white People perfectly white. The *Epidermis* is ever found abſolutely void of Blood-Veſſels: upon which occaſion the Author offers to lay Two Guineas with Mr. *St. Andre*, who, he ſays, falſly aſſerts he has Preparations ſhewing theſe Veſſels, and has pretended to ſhow them to ſome of his Countrymen the *Dutch*. He adds, that he gueſſes the Occaſion of his Miſtake to be thus: The Skin of new-born Infants, in ſome certain Places, if it be carefully ſeparated from all Fat, is ſo fine and thin, that it becomes like the *Epidermis* in Adults. This no doubt is extremely full of Veſſels, and is what he has imagined to impoſe upon Mr. *St. Andre*.

§ IX. He treats of human Bones, in which Search he has long laboured: He obſerves the *Epiphyſes* up-

on the Ends of the Bones are chiefly faſtened to them by the *Perioſteum*; which being taken off, they eaſily fall aſunder. 'Tis a Miſtake, that we vulgarly think this is done by means of an intermediate Cartilage: The Truth is, both the *Epiphyſes* and Ends of the Bones, at firſt, are cartilaginous; but in Time become bony, and then are only joined by the *Perioſteum*. The Oſſification always begins in the middle of Bones. Sometimes he has found human Bones ſo void of Cavities, that he has made Knife-Handles of them: It has been thought that cartilaginous Parts were exſanguious; but falſly, as he demonſtrates by ſeveral Preparations thereof.

§ X. He conſiders the *Papillæ* of the nervoſe Tunic in the Inſide of the Stomach, and finds that the Figure of them is roundiſh, in that Part of the Stomach over which the Spleen is fixt; but longiſh in other Parts thereof, and in the Inſide of the *Jejunum*. He takes Notice, that the Fabrick of the Womb is made of much the ſame Sort of thick muſcular Fibres as the Bladder, both to facilitate their proper Excluſion; particularly theſe Fibres are more remarkable upon the *Fundus Uteri*, to which Part the *Placenta* moſt generally faſtens its ſelf, and moſt evidently for this Reaſon.

F I N I S.

E R R A T U M.

P. 402. *l.* 9. *pro* indicium *l.* judicium.

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Norwich, Oct. 5th 1723.

THESE Stones (*Vid. Fig.* 1, 2, 3, 4, 5.) were voided by a poor Woman, *per Anum*, on the 26, 27, and 28th of *March* laſt paſt, who was then pregnant about the 11, or 12th Week, according to Computation. I was call'd in the Night to this poor Woman on the 23d, who in Appearance was in the Extremity of a Convulſion Fit, attended with violent Vomitings, which when over, ſhe complain'd of great Pain in her Back, from her Reins downward to the *Anus*, upon which I blooded her, order'd ſome *Anti-Emeticks*, and left her: She continued with much Pain the whole Day; on the 24th, in the Night, her Fits return'd again with double Force, her Pains alſo increaſing like unto Labour-Pains, put me upon further Inquiry, but nothing appear'd more than ordinary; the Extremity of Pain drove me to the Uſe of Glyſters, which was attempted, but none could be thrown up, although repeated by one and another of the moſt experienced Nurſes, upon which I gave her a gentle Draught, which ſhe obſerved increas'd her Pain with a ſtrong *Teneſmus*, that continued near three Hours before the largeſt Stone appear'd, which ſtopp'd at the upper Part A, D, *Fig.* 1. but was quickly remov'd by preſſing the lower Protuberance C, upon which, with a plentiful Diſcharge, ſhe had

Jos: Banks

V. *A Botanical Deſcription of the Flower and Seed-Veſſel of the Plant, called* Crocus Autumnalis Sativus, *that produces the true* Engliſh Saffron *of the Shops: With a Figure. By* Dr. James Douglas, *Honorary Fellow of the* College *of* Phyſicians, *and Fellow of the* Royal Society.

VI. *Some Account of Mr.* Leeuwenhoek's *curious* Microſcopes, *lately preſented to the* Royal Society. *By* Martin Folkes, *Eſq; Vice-Preſident of the* Royal Society.

VII. *The Bills of Mortality,* &c. *of ſeveral conſiderable Towns in* Europe. *Beginning with the Year* 1717, i. e. *from* Chriſtmas 1716, *to* Chriſtmas 1717. *Extracted from the* Acta Breſlavienſia. *By* Conr. Joach. Sprengell, *M. D. R. S. S. & Coll. Med. Lond. Lic.*

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Eaſe, ſlept ſome Hours, waking with a Deſire to ſtool, and voided with it the 2d and 3d; and the next Day, at four Hours Diſtance, the other two. She recovered perfectly, and was deliver'd of a very fine living Girl, on the 24th of *Auguſt* paſt. Upon Inquiry, it ſeems, ſhe had been frequently troubled, for fourteen Years paſt, with Pains in her Side and Stomach without Vomitings; which is all ſhe remembers.

The Largeneſs of the Stones, their Seat and Subſtance, is what to me ſeems worthy Speculation; their being all alike in Colour and Weight, according to their Dimenſions, is the Reaſon I broke but one.

Wt. of the Stones.	*oz.*	*dwts.*	*gr.*	Their Dimenſions in Circumference.	*Inch.*			*Inch.*
Fig. 1.	2	16	12	A. B. C. D.	8	A. D. the top of the Stone oval.		6 $\frac{5}{8}$
Fig. 2.		8	12	E. F. G. H.	5 $\frac{1}{8}$	E. G.		4 $\frac{5}{8}$
Fig. 3.		7	3	I. K. L. M.	5	I. L.		3 $\frac{5}{8}$
Fig. 4.		7	12	N. O. P. Q.	4 $\frac{6}{8}$	N. P.		3 $\frac{7}{8}$
Fig. 5.		5	13	R. S. T. U.	4 $\frac{3}{8}$	R. T.		4 $\frac{1}{8}$

1. A Shell taken of the Stone at the End 2. The Stone and Shell being like a Cheſnut ſoft and like Wool, cutting into the Stone at 3, I found it hard.

II. *Epiſtola Viri Doctiſſimi* Johannis Hoogvlietii *ad* Jacobum Jurin, *M. D. R. S. Secr. De Epiſtolis duabus Poſthumis Viri Celeberrimi* Antonij a Leeuwenhoek, *R. S. S.*

SEnex noſter venerandus *Leeuwenhoekius*, jam in agone Mortis verſans, ac nihilominus artis ſuæ memor, me ad ſe vocari juſſit, attollenſque oculos jam gravatos morte, verbis ſemiabruptis me rogabat, vellemne haſce binas literas ex vernaculo in Latinum Sermonem vertere, tibique, Vir Ampliſſime, mittere. Ut ergo hiſce tanti viri, quo abhinc jam aliquot annos uſus fueram familiariſſime, parerem præceptis, non poſſum, quin tibi, Vir eruditiſſime, hoc extremum, Viri mihi amiciſſimi morientis, munus mittam, ſperans fore ut hæc ultima ejus conamina tibi grata ſint futura.

Delphis in Batavis,
pridie Nonas Sept.
1723.

III. *De Globulis in Sanguine & in Vini Fœcibus. Epiſtola poſthuma Domini* Antonij a Leeuwenhoek, *Societatis Regiæ Londinenſis, dum viveret, Sodalis digniſſimi, ad* Jacobum Jurin, *R. S. Secr.*

Delphis in Batavis.

EX proximis tuis literis Septimo Kalendas *Julii* datis, innotuit mihi, nobiliſſimos D. D. Regiæ Societatis, meas tres ultimas epiſtolas perlibenter accepiſſe, quod mihi gratiſſimum erat intellectu; Tibique, Vir doctiſſime, placuiſſe, tuas obſervationes de globulorum ſanguineorum magnitudine, meis obſervationibus congruere. Porro, dicis, Vir doctiſſime, non credo hanc explorationem fore indifferentem, ſeu inutilem, quoniam non impoſſibile eſt, quin illa obſervatio de globulorum ſanguineorum magnitudine in variis animalibus, una cum ſuis parvulis vaſculis, ductura ſit nos aliquando ad detectionem ubi, & quibus mediis hi globuli formentur, & inde determinatam craſſitudinem in eodem animali conſervent.

Deinde dicis, mi doctiſſime, hoc ampliori tua exploratione bene dignum eſt.

Ad hæc mihi aſſumo tibi, Vir eruditiſſime, objicere, me ad imaginationem eam adduci, nos nunquam ad exploratione illam perventuros, quomodo ſcilicet hi globuli ex materia fluida ad magnitudinis determinatæ globulos ſint coagulaturi.

Multis

Multis abhinc annis ad me aſportari juſſi vinum fermentans, quia hoc Vinum globulos producit fere ſanguineis æquales, quos vini fœces vocamus: & quamvis tale vinum microſcopio apponerem, tamen nil aliud videbam, quam innumerabilem multitudinem parviſſimorum globulorum aëreorum, ſurſum ad ſuperficiem vini adſcendentium, & ſecum illos globulos, quos vini fœces nominamus, ducentium. Cum jam in ſuperficiem vini venerant, ſeparabantur vini fœces a globulis aëris, & fundum repetebant, mihi non apparente, quomodo globuli, quos dicimus vini fœces, formabantur: & ſimulac, ni fallit memoria, globuli illi inferius deſcendiſſent, exibat ex globulo quoque iterum globulus aëreus, & ita denuo ad ſuperficiem Vini devehebatur.

Imaginor mihi, coagulationem illam, ac determinatam globulorum ſanguineorum magnitudinem à rerum primordiis eſſe creatas; nam ſi unus globulus altero major erat, ſuſpicamur exinde inordinatam circulationem fore ſecuturam, quoniam ſanguinem per varia vaſcula ſanguinea rapidè transfluentem vidi, quæ adeo exilia erant, ut ſimplex ſaltem globulus tranſire potuerit.

IV. *Ejuſdem*

IV. *Ejuſdem Viri Clariſſimi ad eundem Epiſtola poſthuma. De Generatione Animalium, & de Palpitatione Diaphragmatis.*

Delphis in Batavis.

INTER alia ex tuis proximis literis, ſeptimo Kalendas *Julii* datis, intellexi, Sententiam meam de generatione tibi videri firmiſſimam omnium, hactenus in lucem editarum; & quod mihi non incognitum erat, quoſdam Anatomicos ſupra mea fundamenta novum ſtruere Syſtema auſos eſſe, affirmantes ovum eſſe proprium nidum, in quo animalculum ſeminis maſculini hoſpitatur, & quod idem ovum ex eo imprægnatum, poſtea per tubam *Fallopianam* deducitur ab ovario ad uterum.

Multos expectavi contradicentes, & doctiſſimus quidam dominus dicebat, poſtquam meum Syſtema de generatione legiſſet, recte putas, ſed vita tua convincendis omnibus non ſufficiet; alius dicebat, me mendacia de animalculis memoriæ prodere.

Paulo ante obitum Domini *Leibnitz*, ſcribebat ille Dominus mihi *Hannonia*, ſe meam ſententiam de generatione amplexiſſe, ſeque in libro quodam, a ſe edito, idem demonſtraſſe, ſed quendam dominum in *Italia* eſſe, qui contra meum Syſtema de generatione aliquid eſſet editurus; atque in *Germania* dominum eſſe, qui cum illo communicaverat totum ovarium in tuba *Fallopiana* repertum eſſe; Profeſſoreſque in *Germania* inveniri, qui animalcula ſeminis maſculini eſſe negabant. Verum enimvero, quamvis contradictiones quamplurimas

paſſus ſim, & adhuc patiar, permanebo in Syſtemate meo, quoniam animalcula in omnigenis ſeminibus inveni, ſi ſaltem animalia rite tractare poſſem, ne exceptis quidem variis avium ac piſcium ſpeciebus.

Porro comperimus in omnibus arborum & plantarum ſeminibus, etiamſi parviſſimis, ſi modo tractari poſſint, plantam eſſe formatam, quam plantam antea comparavi cum animalculis ſeminis maſculini. Et farinoſa materia in ſeminibus plantarum plantis nutrimento eſſe debet tamdiu, quam planta ſuos ejecerit radices, & ex terra ali poſſit.

Doctiſſime Vir, concede mihi libertatem dicendi, me percipere non poſſe, quomodo poſitiones adeo vanas ſtatuere, eaſque in lucem edere audeant, quod animalcula ſeminis maſculini in utero vel tuba *Fallopiana* effuſi, poſtea per tubam *Fallopianam* deducerentur ab ovario ad uterum. Hæ poſitiones ſunt adeo omni fundamento carentes, ut ulteriori contradictione indignæ ſint.

Ulterius dicis, eruditiſſime Vir, meam priſtinæ ſanitati reſtitutionem tibi gratam fuiſſe, pro qua benignitate erga me gratias ago maximas, & tibi dicere cogor, me multis ab hinc annis pro certo habuiſſe, quod diaphragma inſtrumentum ſit adeo magnum, ut totum abdomen continue moveat, quo motu cibi in ventriculo & inteſtinis adeo conteruntur, ut in materiam tam fluidam redigantur, quæ apta eſt, ut intret parvula illa vaſcula ſanguinea, quæ multa in inteſtinorum cavitatibus ſita ſunt: non autem per oſcula illorum vaſculorum, ut quidam hominibus perſuadere conati ſunt, ſed me judice per tenues tunicas illorum parviſſimorum vaſculorum ſanguineorum.

Si jam ponamus arteriam in corpore bene conſtituto, intra horæ unius ſpatium ter millies & ſexcenties pulſare, quatuorque pulſus fieri in una reſpiratione, computabimus nongentas reſpirationes ſpatio unius horæ;

ræ, ac toties fiet preſſio ventriculi & inteſtinorum, quam voco ſubactionem in ventriculo & inteſtinis contentorum.

Sit mihi quoque venia tibi, doctiſſime Vir, dicendi, quod duos abhinc menſes varias lentas palpitationes per diaphragma ſenſerim: quare cogitabam de tuba quadam vitrea, à me inventa, ad ſpiritum cujuſdam liquoris in pectus ducendum, ut experimentum facerem, num inſolitus ille diaphragmatis motus, quem cordis palpitationem vocant, ſedari poſſet.

Implevi ergo meam tubam ad altitudinem trium tranſverſorum digitorum ſpiritu vini, in quo jam diu hæc aromata fuerant infuſa, nempe nuces moſchatæ, macis, & parum garyophilloruin, ſed cinnamomi multum, ut & croci, & inſpiravi aërem tranſeuntem per hunc ſpiritum vini, & quidem non modeſtè, ſed fortiter aërem in pulmonem impuli, quo diaphragma, quod fortis membrana eſt, valde extendebam, experiendi gratia, num palpitationem, vel inordinatum diaphragmatis motum, hoc facto componere poſſem, quod illo tempore bene ſucceſſit: Sed poſtea quidem evenit, ut experimentum hoc, quamvis aërem tam fortiter in pectus inducerem, ut preſſus aër cum tuſſi ex guttere erumperet, expectationem meam eluſerit.

Sententia tua mihi longe viſu erat gratiſſima, nempe quod diaphragmatis palpitatio validiori niteretur fundamento, quam illa cordis.

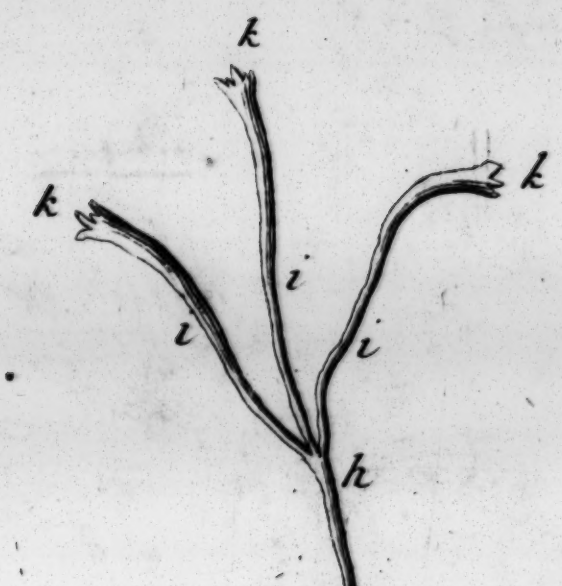




Fig. 6.



Fig. 2.

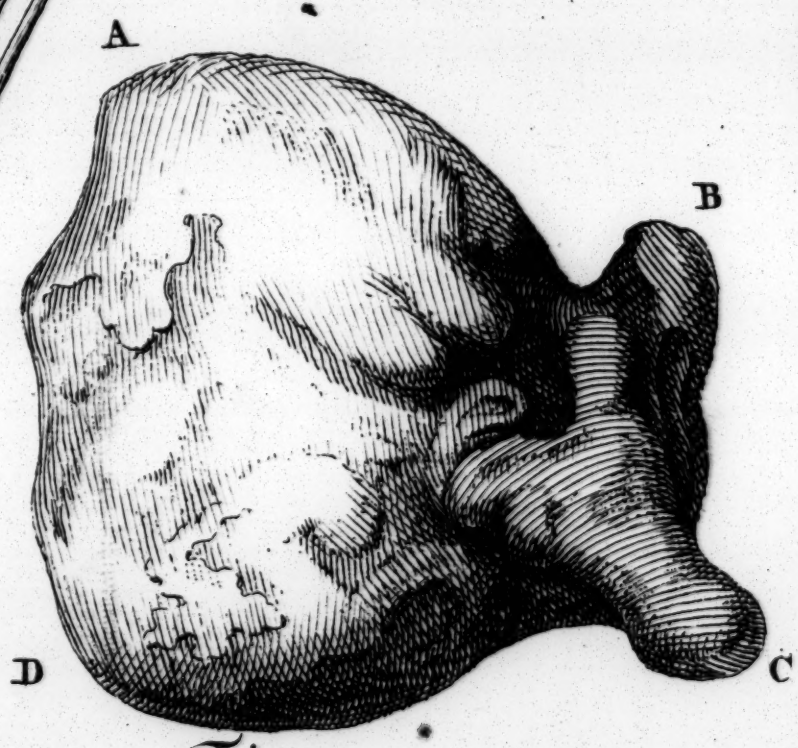


Fig. 1.

Fig. 4.



Fig. 3.

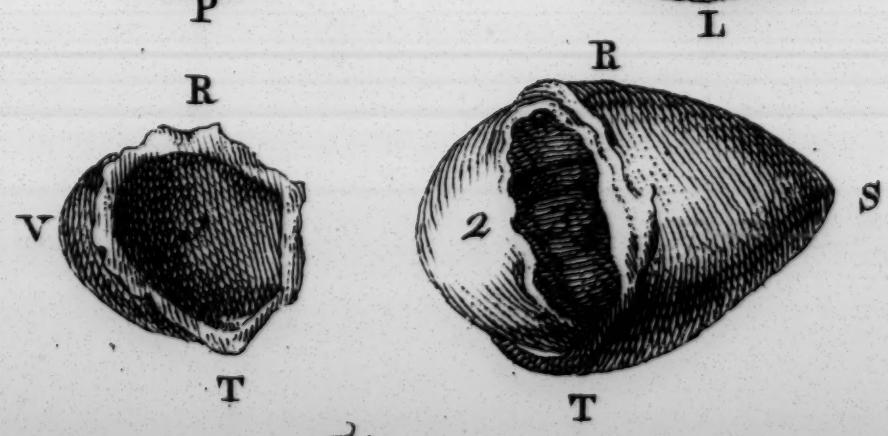


Fig. 5.

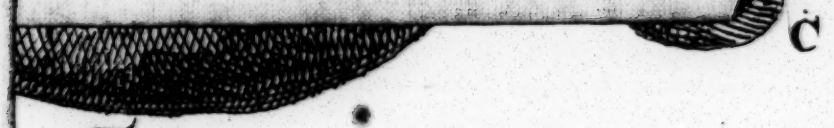


Fig. 1.

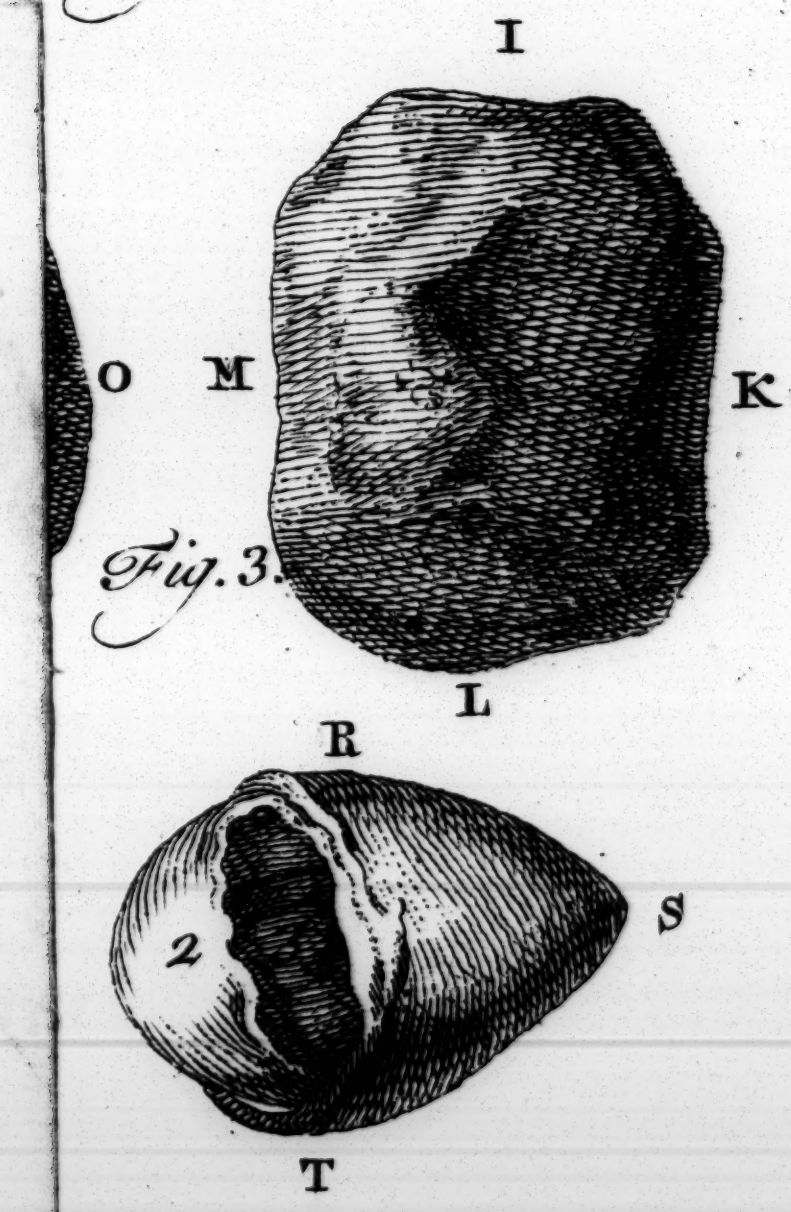


Fig. 3.

Fig. 5.

V. *A Botanical Deſcription of the Flower and Seed-Veſſel of the Plant, called* Crocus Autumnalis Sativus, *that produces the true* Engliſh Saffron *of the Shops: With a Figure. By* Dr. James Douglas, *Honorary Fellow of the* College *of* Phyſicians, *and Fellow of the* Royal Society.

THE Flower of this curious Plant is of the Lilly Kind, monopetalous, infundibuliformis, without any *Calyx* or *Perianthium*, its long fiſtulous Beginning being afterwards expanded into ſix beautiful oblong Segments. *Vid. Lit.* A. A. *Fig.* 6.

It conſiſts of the following Parts, *viz.* the *Petalum*, the *Stamina*, the *Apices*, the *Ovarium*, and the *Stylus*; with its *Capillamenta Tubiformia*, of all which in Order.

PETALON.

The *Petalum* is diſtinguiſhed into a long, hollow, or fiſtulous Part, which lies incloſed within the common and proper *Involucra* of the Plant, ariſing from the Top of the *Ovarium*, or *Seed-Veſſel*, and ſix Segments. *Vid. Lit. a. a.*

While this narrow, tubulous Part runs between the Leaves and Integuments that ſurround them, it is of a white Colour; but, aſſoon as it is diſengaged from theſe, it inſenſibly acquires a Purple Colour, which, a little before its Diviſion, as it begins to be enlarged, and grow more open, inclines to a Red.

This narrow fiſtulous Part of the Flower, about 1 or 2 Inches above the *Theca Communis*, forms ſix foliaceous Segments, or divides into ſo many oblong Purple-coloured *Petala*. *Vid. Lit. b. c.*

Three of theſe Flower-Leaves are larger than the other three, but, in all other Reſpects, are much alike. *Vid. Lit. c. c. c.*

The Length of the largeſt is from 1 ¾, to 2 Inches; the Breadth ſeldom above ½ Inch: The ſhorter Leaves are from 1, to 1 ¾ Inch in Length, their Breadth being ſomething leſs in Proportion.

The Inſide of each *Petalum* is of a Violet Purple-Colour, vein'd with a few ſmall Lines of a deeper Dye, running length-ways, intermixed with White, or the whole is beautifully checquered with Blue and White Colours.

The Outſide is of a whiter Blue, with ſeveral whitiſh Riſings or Ridges, and juſt at the Bottom of the Leaf it is of a deeper Blue; the three ſmall Leaves (*Vid. Lit. b. b. b.*) are much of the ſame Colour, only the Purple ſeems to be ſomething deeper.

The Number of the *Petala* is, for the moſt Part, 6; yet, in ſome Flowers we may obſerve 7, or 8; but then they are not ſo large as when they are fewer.

STAMINA.

In every Flower there are three *Stamina*, or Chives, (*Vid. Lit. d. d. d.*) properly ſo called, ariſing from the inner Surface of the tubular Part of the Flower, juſt before its Diviſion into the *Petala*, where they make, for ſome Space, an apparent Ridge, and then they ſtand

upright, oppoſite to the three large Leaves; they are of a whitiſh Colour, inclining to a light Purple, being but little above $\frac{1}{4}$ of an Inch in Length.

In thoſe Plants that have 7 or more *Petala*, the Number of the *Stamina* is likewiſe encreaſed to 5, or more.

APICES.

Each of theſe *Stamina* has its proper *Apex*, (*Vid. Lit. e. e. e.*) which is a peculiar longiſh Subſtance, ſtanding upright, oppoſite to the larger Flower-Leaves, of a Yellow Colour, forked, not unlike the Tongue of a ſmall Bird, at the lower End, where it is fixed to the *Stamen*; here likewiſe it is broadeſt, but as it aſcends it becomes narrower, and its upper Extremity is a little crooked, or turned to one Side: It ſeldom exceeds $\frac{1}{2}$ Inch in Length.

It appears as if it was double, with a longitudinal Furrow in the middle, in which Hollow the *Stamen* ſeems to be faintly continued for ſome Space.

When the Plant is full grown, they are all loaded with that Kind of ſmall Duſt called *Farina fœcundans*.

OVARIUM.

Called likewiſe the *Vaſculum Seminale*, and *Piſtillum* by ſome. *Vid. Lit. f. f.*

It is a particular Body, which ariſes from the Top of the *Pedunculus*, (*Vid. Lit. g.*) about $\frac{1}{4}$ of an Inch long, or a little more, of a deep White Colour, three cornered, and divided into three *Loculamenta*, or *Capſulæ*, in which the Seeds (which however ſeldom come

to Perfection with us) are formed, growing bigger and bigger after the Flower falls off; nay, even in this blooming State, if you cut this Veſſel acroſs the middle, you may perceive the whitiſh Rudiments of the Seeds.

STYLUS.

From the upper Part, or *Apex*, of the *Ovarium*, ariſes the *Stylus*, (*Vid. Lit. b.*) which is a long ſlender Tube, that lies encloſed within the tubulous or fiſtular Portion of the Flower, being there of a whitiſh Colour, but changing into a Yellow before its Diviſion.

This Stylet ordinarily ſplits into 3 Parts, juſt oppoſite to the Top of the *Stamina*, where the *Apices* take their Riſe, (*Vid. Lit. i, i, i.*) and thus far it ſtands upright in the Middle of the *Stamina*; for the ſake of which only, this Plant is cultivated, and being prepared, (as ſhall hereafter be deſcribed) makes the true Saffron of the Shops, which we ſo frequently uſe in Phyſick.

I call theſe Parts of the *Stylus*, from their Figure and Shape, *Capillamenta Tubiformia*, or, *Appendices Styli Salpingoeides*, in as much as they very exactly repreſent a Trumpet, and are not unlike the *Falloppian Tube* in Women, being narrow at their Origin, and growing gradually larger towards their other Extremity; which, like the common Trumpet, is open and expanded; and, like the *Tubæ Falloppii*, is jagged, or fringed at the Edge. *Vid. Lit. k, k, k.*

It may alſo be very fitly named *Crocus officinarum*, becauſe that is the Part only that is uſed in the Shops.

They are of a Yellow Colour, juſt at their Beginning, continued from the upper Part of the *Stylus*, but af-

afterwards they are all of a deep Red Colour, only their jagged Extremities are tipt with a White inclining to a Yellow.

These *Tubæ*, or *Capillamenta*, are from 1, to 1 ½ Inch in Length.

The *Stylus*, while undivided, is ſtrong enough to ſupport itſelf, being encloſed within the tubular Part of the Flower; but the *Capillamenta* being very weak and ſlender at their Beginning, this occaſions them to hang down between the *Petala*.

FIGURE 6.

Repreſents a Root of the Saffron-Plant, that h aswo Stalks encloſed in one common *Vagina*, the whole Flower with the *Stamina* and *Apices* in one, and the *Stylus* only in the other; with the Leaves, *Pedunculi*, and *Ovarium* in both, being fairly delineated from the Life.

A A. The Flower expanded into ſix beautiful Segments.
a a. The Fiſtulous Part of the Flower.
b. c. The ſix Petala.
c. c. c. The three larger Petala.
b. b. b. The three ſmaller ones,
d. d. The three Stamina, *or Chives.*
e. e. e. The three Apices.
f. f. The Vaſculum Seminale.
g. g. The Pedunculi.
h. h. The Stylus.
i. i. i. The three Capillamenta Tubiformia.
k. k. k. The jagged Extremity of the Capillamenta.
B. B. The Root.
C. C. The Graſſy Leaves.

VI. *Some*

VI. *Some Account of Mr.* Leeuwenhoek's *curious* Microscopes, *lately presented to the* Royal Society. *By* Martin Folkes, *Esq; Vice-President of the* Royal Society.

IT is now above 50 Years, since the late *Mr. Leeuwenhoek* first began his Correspondence with the Royal Society; when he was recommended by *Dr. Regnerus de Graaf*, as a Person already considerable by his Microscopical Discoveries, made with Glasses contrived by himself, and excelling even those of the famous *Eustachio Divini*, so much talk'd of in the learned World: And as he has ever since that Time apply'd himself, with the greatest Diligence and Success, to the same Sort of Observations, no Doubt can be made of the Excellency of those Instruments he so long us'd, so much improv'd, and upon the fullest Experience so often commended in his Letters; great Part of which, at his Decease, he thought fit to bequeath to this Society, for whom he ever expres'd the greatest Esteem and Respect.

He had, indeed, intimated this Design in several of his Letters, and in his last Will and Testament gave Orders, that the Glasses should be delivered as soon as conveniently might be after his Decease; which was accordingly done, by the Directions of his surviving Daughter, *Mrs. Maria Van Leeuwenhoek*, to whose great Care we are oblig'd, for the safe and speedy Delivery of this very curious and valuable Present.

The

The Legacy consists of a small *Indian* Cabinet, in the Drawers of which are 13 little Boxes or Cases, each containing two Microscopes, handsomely fitted up in Silver, all which, not only the Glasses, but also the *Apparatus* for managing of them, were made with the late *Mr. Leeuwenhoek*'s own Hands: Besides which, they seem to have been put in Order in the Cabinet by himself, as he design'd them to be presented to the Royal Society, each Microscope having had an Object placed before it, and the Whole being accompany'd with a Register of the same, in his own Hand-Writing, as being desirous the Gentlemen of the Society should, without Trouble, be enabled to examine many of those Objects, on which he had made the most considerable Discoveries.

Several of these Objects yet remain before the Microscopes, tho' the greater Number are broken off, which was probably done by the shaking of the Boxes in the Carriage. I have, nevertheless, added a Translation of the Register, as it may serve to give a juster Idea of what *Mr. Leeuwenhoek* design'd by this Legacy, and also be of Use, by putting any curious Observer in Mind of a Number of Minute Subjects, that may in a particular Manner deserve his Attention.

The 13 Cases abovemention'd are numbered from 15 to 27 inclusively, corresponding to which is the Register of the Objects, Two to every Case, as follows.

No. 15. Globules of Blood, from which its Redness proceeds.

A thin Slice of Wood of the Lime-Tree, where the Vessels conveying the Sap are cut transversely. No. 16.

N°. 16. The Eye of a Gnat.

N°. 17. A crooked Hair, to which adhéres a Ring-Worm, with a Piece of the Cuticle.

A ſmall Hair from the Hand, by which it appears thoſe Hairs are not round.

N°. 18. Fleſh of the Codfiſh (*Cabeljaeuw*) ſhewing how the Fibres lie oblique to the Membranes.

An Embrio of Cochineal, taken from the Egg, in which the Limbs and Horns are conſpicuous.

N°. 19. Small Pipes, which compoſe the Elephant's Tooth.

Part of the Cryſtalline Humour, from the Eye of a Whale.

N°. 20. A Thread of Sheeps-Wool, which is broken, and appears to conſiſt of many leſſer Threads.

The Inſtrument, whence a Spider ſpins the Threads, that compoſe his Web.

N°. 21. A Granade, or Spark made in ſtriking Fire.

The Veſſels in a Leaf of Tea.

N°. 22. The *Animalcula in Semine Maſculino*, of a Lamb taken from the Teſticle, *Jul.* 24. 1702.

A Piece of the Tongue of a Hog, full of ſharp Points.

N°. 23. A Fibre of Codfiſh, conſiſting of long ſlender Particles.

Another of the ſame.

N°. 24. A

N°. 24. A Filament, conveying Nouriſhment to the Nutmeg, cut tranſverſly.

Another Piece of the ſame, in which the Figure of the Veſſels may be ſeen.

N°. 25. Part of the Bone or Tooth abovementioned, conſiſting of hollow Pipes.

An exceeding thin Membrane, being that which cover'd a very ſmall Muſcle.

N°. 26. Veſſels by which Membranes receive Nouriſhment and Increaſe.

A Bunch of Hair from the Inſect call'd a Hair-Worm.

N°. 27. The double Silk, ſpun by the Worm.

The Organ of Sight of a Flie.

It were endleſs to enter into any Particulars, of what is to be obſerved in any of theſe Objects, or indeed to give any Account of *Mr. Leeuwenhoek*'s Diſcoveries; they are ſo numerous as to make up a conſiderable Part of the *Philoſophical Tranſactions*, and when collected together, to fill four pretty large Volumes in Quarto, which have been publiſh'd by him at ſeveral Times: And of ſuch Conſequence, as to have opened entirely new Scenes in ſome Parts of *Natural Philoſophy*, as we are all ſenſible, in that famous Diſcovery of the *Animalcula in Semine Maſculino*, which has given a perfectly new Turn to the Theory of Generation, in almoſt all the Authors that have ſince wrote upon that Subject.

For the Conſtruction of theſe Inſtruments, it is the ſame in them all, and the *Apparatus* is very ſimple and convenient: They are all ſingle Microſcopes, conſiſting each of a very ſmall double Convex-Glaſs, let into

a Socket, between two Silver Plates rivetted together, and pierc'd with a ſmall Hole: The Object is placed on a Silver Point, or Needle, which, by Means of Screws of the ſame Metal, provided for that Purpoſe, may be turn'd about, rais'd, or depreſs'd, and brought nearer, or put farther from the Glaſs, as the Eye of the Obſerver, the Nature of the Object, and the convenient Examination of its ſeveral Parts may require.

Mr. *Leeuwenhoek* fix'd his Objects, if they were ſolid, to this Silver Point, with Glew; and when they were Fluid, or of ſuch a Nature as not to be commodiouſly view'd unleſs ſpread upon Glaſs, he firſt fitted them on a little Plate of Talk, or exceſſively thin-blown Glaſs, which he afterwards glewed to the Needle, in the ſame Manner as his other Objects.

The Obſervation, indeed, of the Circulation of the Blood, and ſome others, require a ſomewhat different *Apparatus*, and ſuch a one he had, to which he occaſionally fix'd theſe ſame Microſcopes; but as it makes no Part of this Cabinet, I ſhall omit giving any farther Account of it, only taking Notice that it may be ſeen in a Letter to the *Royal Society*, of the 12th of *January*, 1689. and printed in his *Arcana Naturæ Detecta*, N°. 69. But I was willing to mention juſt ſo much, as it may ſerve to ſhew the univerſal Uſe of theſe Microſcopes, and as it induces me (among other Things) to believe, theſe were the Kind of Microſcopes generally, if not ſolely, us'd by this curious Gentleman in all his Obſervations, and to which we are oblig'd for his moſt ſurprizing Diſcoveries.

Another Particular, to the ſame Purpoſe, I would not omit, and that is, That upon the late Queen *Mary*'s

doing Mr. *Leeuwenhoek* the Honour of a Visit at *Delft*, and viewing his Curiosities with great Satisfaction, he presented her with a Couple of his Microscopes, which, as I have been inform'd by one who had them a considerable Time in his Hands, were of the same Sort as these, and did not any ways differ from one of the 13 Cases contain'd in the Drawers of this Cabinet.

The Glasses are all exceedingly clear, and shew the Object very bright and distinct, which must be owing to the great Care this Gentleman took, in the Choice of his Glass, his Exactness in giving it the true Figure; and afterwards, amongst many, reserving such only for his Use, as he, upon Tryal, found to be most excellent. Their Powers of magnifying are different, as different Sorts of Objects may require; and, as on the one Hand, being all ground Glasses, none of them are so small, and consequently magnify to so great a Degree, as some of those Drops, frequently us'd in other Microscopes; yet, on the other, the Distinctness of these very much exceeds what I have met with in the Glasses of that Sort; and this was what Mr. *Leeuwenhoek* ever principally propos'd to himself, rejecting all those Degrees of magnifying in which he could not so well obtain that End; for he informs us in one of his Letters, where he is speaking of the excessive Praise some give to their Glasses on this Account, that although he had above Forty Years had Glasses by him of an extraordinary Smallness, he had made but very little Use of them; as having found, in a long Course of Experience, that the most considerable Discoveries were to be made with such Glasses as, magnifying but moderately, exhibited the Object with the most perfect Brightness and Distinction.

But however excellent these Glasses may be judg'd, Mr. *Leeuwenhoek*'s Discoveries are not entirely to be imputed to *their* Goodness only: His own great Judgment, and Experience in the Manner of using them, together with the continual Application he gave to that Business, and the indefatigable Industry with which he contemplated often and long upon the same Subject, viewing it under many and different Circumstances, cannot but have enabled him to form better Judgments of the Nature of his Objects, and see farther into their Constitution, than it can be imagined any other Person can do, that neither has the Experience, nor has taken the Pains this curious Author had so long done.

Nor ought we to forget a Piece of Skill, in which he very particularly excell'd, which was that of preparing his Objects in the best Manner, to be view'd by the Microscope; and of this I am perswaded, any one will be satisfied, who shall apply himself to the Examination of some of the same Objects as do yet remain before these Glasses; at least, I have my self found so much Difficulty in this Particular, as to observe a very sensible Difference between the Appearances of the same Object, when apply'd by my self, and when prepared by Mr. *Leeuwenhoek*, tho' view'd with Glasses of the very same Goodness.

I have the rather insisted upon this, as it may be a Caution to us, that we do not rashly condemn any of this Gentleman's Observations, tho' even with his own Glasses, we should not immediately be able to verify them our selves. We are under very great Disadvantages for want of the Experience he had, and he has himself put us in Mind, more than once, that those who are

the beſt skill'd in the Uſe of Magnifying-Glaſſes, may be miſled, if they give too ſudden a Judgment upon what they ſee, or 'till they have been aſſured from repeated Experiments. But we have ſeen ſo many, and thoſe of his moſt ſurprizing Diſcoveries, ſo perfectly confirm'd, by great Numbers of the moſt curious and judicious Obſervers, that there can ſurely be no Reaſon to diſtruſt his Accuracy in thoſe others, which have not yet been ſo frequently or carefully examin'd.

Upon the whole, it is to be hoped, ſome of the Society will purſue thoſe Enquiries, the late Poſſeſſor of theſe Microſcopes was ſo deſervedly famous for; and that as we have loſt in Mr. *Leeuwenhoek* a moſt worthy Member, and a moſt valuable Correſpondent, this laſt Piece of his Reſpect to the *Royal Society* will not only enrich our Repoſitory, but both encourage and enable ſome other diligent Obſerver to proſecute the ſame curious and uſeful Diſcoveries.

VII. *The*

VII. *The Bills of Mortality, &c: of several considerable Towns in* Europe. *Beginning with the Year* 1717, i. e. *from* Christmas 1716, *to* Christmas 1717. *Extracted from the* Acta Breslavienſia. *By* Conr. Joach. Sprengell, *M. D. R. S. S. & Coll. Med. Lond. Lic.*

THE Uſefulneſs of this Sort of Regiſters is now ſo well known to the Learned World, from the Labours of many curious and inquiſitive Perſons in Political Arithmetick, that we conceive the following will need no Recommendation to render them acceptable to the Publick.

Breſlaw, *in* Sileſia.

Buried.		*Chriſtened.*		
In January,	91	Males		584
February,	113	Females		576
March	136			1160
April	108	*Among the Buried were*		
May	127	Married Men		226
June	144	Married Women		144
July	144	Widows & Widowers		157
Auguſt	208	Bachelors		60
September	128	Maidens		57
October	96	Boys and Girls	under Ten Years old,	419
November	113			397
December, only till the 24th,	77	Stillborn	Boys	37
			Girls	17
	1485			1514

N. B. Here

N. B. Here, in the Sum Total, are 29 more than in the Number of the Buried above, by Reaſon of ſeveral Stillborn Children which had no regular Burial, and ſo were not reckon'd.

In the Imperial Town Vienna, *there died,*

Young People	3179
Old	2026
Total	5205

Among which were,

Of 90 Years old	2	Of 99	2
91	1	100	1
92	3	102	2
93	1	103	1
94	3	104	1
95	2	115	1
96	3		

Born and Chriſtened —— 4030 Children.

In *Dreſden, Saxony,* died —— —— 1908
Chriſten'd —— —— 1443

In *Dantzick* died —— 1605
Chriſtened —— 2102

In *Eſperies,* or *Eperies,* alias *Epperies,* a Town in Upper *Hungary,* died —— 132
Chriſten'd —— 157
Moſt of theſe died of the Small-Pox.

The

The Bills *of* Mortality *of the Year* 1718. i. e. *from* Christmas 1717, *to* Christmas 1718.

BRESLAW.

Buried.		*Christened.*	
From the 25th of Dec. to the 31st.	21	Males	598
January	129	Females	554
February	112		1152
March	108		
April	98	*Among the Dead were,*	
May	88	Married Men	238
June	97	—— Women	141
July	86	Widows & Widowers	122
Auguſt	118	Bachelors	60
September	98	Virgins	60
October	119	Children to ten Years of Age, { Boys	282
November	100	{ Girls	280
December, till the 24th,	81	Stillborn { Boys	47
		{ Girls	25
Total	1255		1255

In *Vienna* died—Men—1432—Women —1129
Boys—1844— Girls —1705

In all——6110.

Amongſt

Amongſt which were froze to Death in the Street	2
Murder'd	2
Kill'd by a Waggon	2
By Falls from Houſes, &c.	11
Kill'd with Swords, Knives and Sabres,	9
By taking wrong Phyſick	1

Among the Dead were found,

8 Perſons of	90 Years old.
7	92
2	93
3	94
3	95
1	96
2	97
2	98
2	99
1	105

Trod to Death by Horſes	4
Drowned	5
Beat to Death	1
Smother'd in a Houſe of Office	4
Cut their Throats	2
Kill'd by the Fall of Houſes	5

Chriſtened.

Males	—2185
Females	—2057
Total	—4242

Amongſt which were 48 Pair of Twins, and once *Tergemini.*

In *Ratisbon* died of the *Lutherans*, 235 Perſons; amongſt which were 117 Children, 13 young Men, and 11 young Women.

The following List *gives an Account of ſeveral Cities in* SAXONY.

	Chriſtened	*Baſtards.*	*Buried.*	*Pair Married.*	*Communicants.*
In Dreſden	1578	99	1412	501	78875
Wittemberg	286	16	317	61	13536
Leipzick	861	68	953	303	
Torgau	136	9	148	54	7917
Freyberg	340	13	373	104	24098
Stollberg	88		112	27	7314
Pulſnitz	73		75	39	4381
Konigsbruck	67		95	16	3351
Elſtra	63		45	11	3021
Bautzen	207	5	135	55	14520
Annaberg	146	19	112	37	8426
Chemnitz	173	4	166	38	10690
Oſchatz	103	3	82	20	5169
Altenburg	141		248	57	12901
Eulenberg	96	5	86	41	6194
Pirna	138	2	133	43	9164
Marienberg	91		194	18	5903
Georgenſtad	182		191	36	3580
Harta, *near* Waldheim	40	3	29	20	3291

This

This presents you with a LIST *for a whole Century, of the Numbers of People Married, Christened, Buried, and Communicants,* viz. *from the Year* 1617, *to* 1717 *inclusive, in the Electoral City of* Freyberg, *a famous and pleasant Town, near the Banks of the* Molde *in* Saxony. *Lat.* 51. *Long.* 32, 43. *about* 8 *Miles* S. W. *from* Dresden.

No Years.	Pair Married.	Christened.	Bastards.	Buried.	Communicants
1617	89	539	4	430	10530
18	122	42	10	384	9631
19	124	495	13	371	9789
20	97	428	10	451	10093
21	106	430	6	507	9676
22	110	380	7	517	9536
23	100	357	8	589	9206
24	96	383	4	417	9509
25	98	375	7	454	10058
26	78	381	6	549	11642
27	108	372	7	331	11027
28	82	371	4	318	10745
29	87	412	19	536	11531
30	80	330	7	1114	11180
1631	135	353	4	284	10524
32	88	425	5	1343	11326
33	174	163	4	879	9131
34	170	375	1	175	7447
35	87	285	9	231	7323
36	61	299	11	181	7590
37	68	386	3	383	7723
38	53	262	9	151	7682

1639

N° Years.	Pair Married.	Christened.	Bastards.	Buried.	Communicants.
1639	45	292	4	354	9609
40	65	268	6	173	7594
1641	61	226	2	163	7562
42	48	309	4	193	8128
43	60	383	7	340	7770
44	65	231	7	156	7699
45	62	196	5	163	7050
46	57	230	6	187	7263
47	59	201	2	136	7173
48	54	197	1	182	7698
49	44	222	5	201	7739
50	65	199	1	162	7639
1651	65	232	1	168	8148
52	50	190	2	202	7948
53	62	208	2	215	8342
54	62	234	3	211	8648
55	73	202	1	194	6351
56	60	237	5	151	8493
57	58	230		174	8730
58	61	198	4	184	8561
59	57	251	3	177	8431
60	66	230		240	8856
1661	47	225	3	217	8962
62	53	203	2	206	9423
63	47	206	2	247	9264
64	48	219	2	179	9279
65	61	213		207	9406
66	65	218	4	216	9979
67	79	223		306	9448
					1668

Nº Years.	Pair Married.	Christened.	Bastards.	Buried.	Communicants.
1668	63	228	5	232	9588
69	55	232		204	9572
70	70	218	4	206	9564
1671	65	237	3	291	10080
72	64	207	2	286	9221
73	69	234	1	215	9912
74	55	228		204	9678
75	60	233	1	246	10093
76	58	226	1	277	9956
77	80	240	3	296	10462
78	70	256	4	302	10422
79	91	225	4	254	10356
80	63	292	4	267	11349
1681	87	285	5	218	11043
82	69	282	7	253	10894
83	77	315	8	333	11054
84	78	334	6	314	10623
85	73	249	4	251	11070
86	73	282	5	243	11488
87	80	327	6	292	11542
88	88	308	11	234	11300
89	59	276	4	301	11393
90	72	290	5	310	11380
1691	72	269	6	289	11724
92	58	284	7	296	12679
93	72	316	10	253	11597
94	65	236	7	355	12533
95	57	239	6	339	13196
96	85	277	10	290	14900

No Years.	Pair Married.	Christened.	Bastards.	Buried.	Communicants.
1697	76	216	4	180	15619
98	73	274	7	218	15677
99	64	264	5	258	16155
1700	74	251	7	310	18569
1701	81	283	10	188	19282
2	88	272	2	239	20383
3	95	271	6	241	20494
4	88	319	11	273	20837
5	72	295	12	357	20743
6	85	332	10	245	21813
7	82	310	18	378	21367
8	83	310	17	288	21838
9	71	302	10	305	21708
10	83	313	15	283	21699
1711	81	327	8	311	22334
12	82	310	9	325	22837
13	87	308	9	340	23627
14	70	349	6	237	23470
15	82	323	8	283	23273
16	105	317	14	361	23371
17	79	373	13	325	23904
Total—	7546	28851	582	30295	1211761

Here is to be obſerved, That in the Years 1625, 26, 27, 32, and 33, the Plague raged very much; as alſo, that in the Year 1630, there died of the Plague meerly, 764. and in 1680, 103. Beſides that, amongſt the Chriſtened in 1713, a Girl was baptized, which was born and bred in *Turkey*, but from *Chriſtian* Parents.

But

But, in general, it may be obſerved, That this Place was more populous before the War than it is at preſent; tho' in this Century it cannot but very much recover and increaſe.

The following LIST we have receiv'd from *Berlin*, conſiſting of all that were Born, Married and Buried in *Pruſſia*, in Four Years.

	Year.	*Born.*	*Pair married.*	*Buried.*
In the Kingdom of *Pruſſia.*—	1715	19606	4571	12000
	16	20669	4530	12155
	17	21443	4743	12301
	18	20994	4287	11047
	Sum—	82712	18331	47503

The next LIST contains the Numbers of all that were Born, Married and Buried, in the reſt of the King of *Pruſſia*'s Dominions in *Germany*, &c. for Four Years.

	Year.	*Born.*	*Pair married.*	*Buried.*
In the Electorate of *Brandenburg.*	1715	14820	4368	11663
	16	15758	4995	13149
	17	16636	4539	10805
	18	17319	4657	12891
	Sum—	64533	18559	48508

In

	Year.	Born.	Pair married.	Buried.
In the *Newmarck.*	1715	5487	1683	4757
	16	4973	2010	4502
	17	7052	1850	4673
	18	6684	1882	5069
	Sum	24196	7125	19001
In the Dutchy of *Magdeburg.*	1715	7185	2064	4982
	16	7225	2186	5602
	17	8746	2306	6291
	18	8325	1934	5744
	Sum	31481	6490	22619
The Dutchy of *Cleve.*	1715	6772	1964	5066
	16	7313	2001	6221
	17	7582	2051	6055
	18	7542	1891	5865
	Sum	29209	7907	23207
The Dutchy of *Pomerania.*	1715	7243	2190	5373
	16	7386	2407	5557
	17	8196	2108	5020
	18	7896	2138	6231
	Sum	30721	8843	22182

The

	Year.	Born.	Pair married.	Buried.
The Principality of *Halberstad.*	1715	2371	710	1834
	16	2567	759	2542
	17	2759	764	1961
	18	2527	715	2022
	Sum	10224	2948	8359
The County of *Hohenstein.*	1715	528	164	406
	16	639	155	444
	17	644	148	449
	18	612	158	416
	Sum	2383	625	1715
The Principality of *Minden.*	1715	1711	579	1618
	16	1788	564	1829
	17	1991	542	1419
	18	1832	552	1486
	Sum	7322	2237	6352
The City of *Meurs.*	1715	406	151	386
	16	439	161	331
	17	454	166	281
	18	470	170	368
	Sum	1769	648	1366

	Year.	Born.	Pair married.	Buried.
In *Geldern.*	1715—	1—	—	
	16—	—	—	
	17—	1990 —	497—	1066
	18—	2053 —	489—	1064
	Sum—	4043 —	986—	2130
	1715—	2188—	679—	1987
The County of	16—	2410—	716—	2349
Ravensberg.	17—	2312—	672—	1817
	18—	2344—	641—	1951
	Sum—	9254—	2708—	8104
	1715—	342—	153—	513
The County of	16—	553—	163—	543
Tecklenberg.	17—	505—	186—	370
	18—	507—	135—	387
	Sum—	1907—	637—	1813
	1715—	628—	213—	484
The County of	16—	699—	154—	638
Lingen.	17—	697—	248—	449
	18—	706—	221—	840
	Sum—	2730—	836—	2411

In

	Years.	Born.	Pair married.	Buried.
In *Lauenburg* and *Butow.*	1715—	585—	144—	362
	16—	587—	169—	420
	17—	586—	118—	366
	18—	554—	153—	321
	Sum—	2312—	584—	1469
In the *French* Colonies.	1715—	—	—	—
	16—	—	—	—
	17—	607—	181—	564
	18—	603—	136—	639
	Sum—	1210—	317—	1203

The Sum Total of all that were Born in 4 Years - - - - - - - } 306006

- - - - of all that were married 81881 *Pair.*
- - - of all that were Buried 217942

More Born than Buried, in Number, 88064

Here is also to be observ'd, that in the Year 1718. there died 84 Persons above 91 Years old, and 32 above 100; and, 1 died in the 116th Year of his Age. Besides in that very Year are reckoned 2088 Bastards.

Here follows a particular List of ſeveral Borough Towns in the Kingdom of Pruſſia, *receiv'd from the* Chancery *of* Koningſberg, *of all that died in the Year* 1718.

In the Borough of	*Died.*
Brandenburg	581
— Schacken	346
— Fiſhauſen	312
— Taxium	456
— Balga	392
— Preuſs Eylau	319
— Bartenſtein	167
— Barthen	185
— Oſterode *and* Hohenſtein	277
— Seheſten	159
— Neudenburg *and* Saldau	330
— Lyck	141
— Oletzko	188
— Angerburg	182
— Rhein	107
— Orſelsburg	220
— Johannisburg	148
— Lotzen	137
— Neuhauſen	148
— Labiau	249
— Raſtenburg	275
— Preuſs Holland	264
— Marungen *and* Liebſtadt	206
— Marienwerder *and* Rieſenburg	393
— Preuſs Marck	312
— Tilſit	529
— Ragnit	381
— Inſterburg	
— Georgenburg	808
— Salau	
— Mummel	556
— Schonberg	126
— Gerdauen *and* Nordenburg	269
— Gilgenburg	109
— Teutſch Eylau	41
— Neuhaff	15
In the three Cities of Koningſberg	1756
Sum	11047

In all theſe forementionʼd Places were Chriſtened 20994
Pair Married 4287

	Died.	Chriſtened.	Married.
In *Dantzick* in the Year 1718.	579	1470	446 Pair.
In *Epperies*	123	173	

In the Royal Hoſpital at *Liſbon* out of 1251 Foundlings maintained by the King, without knowing their Parents, there died 469, remained 782.

N. B. *The Remainder of theſe Liſts will be communicated at another Opportunity.*

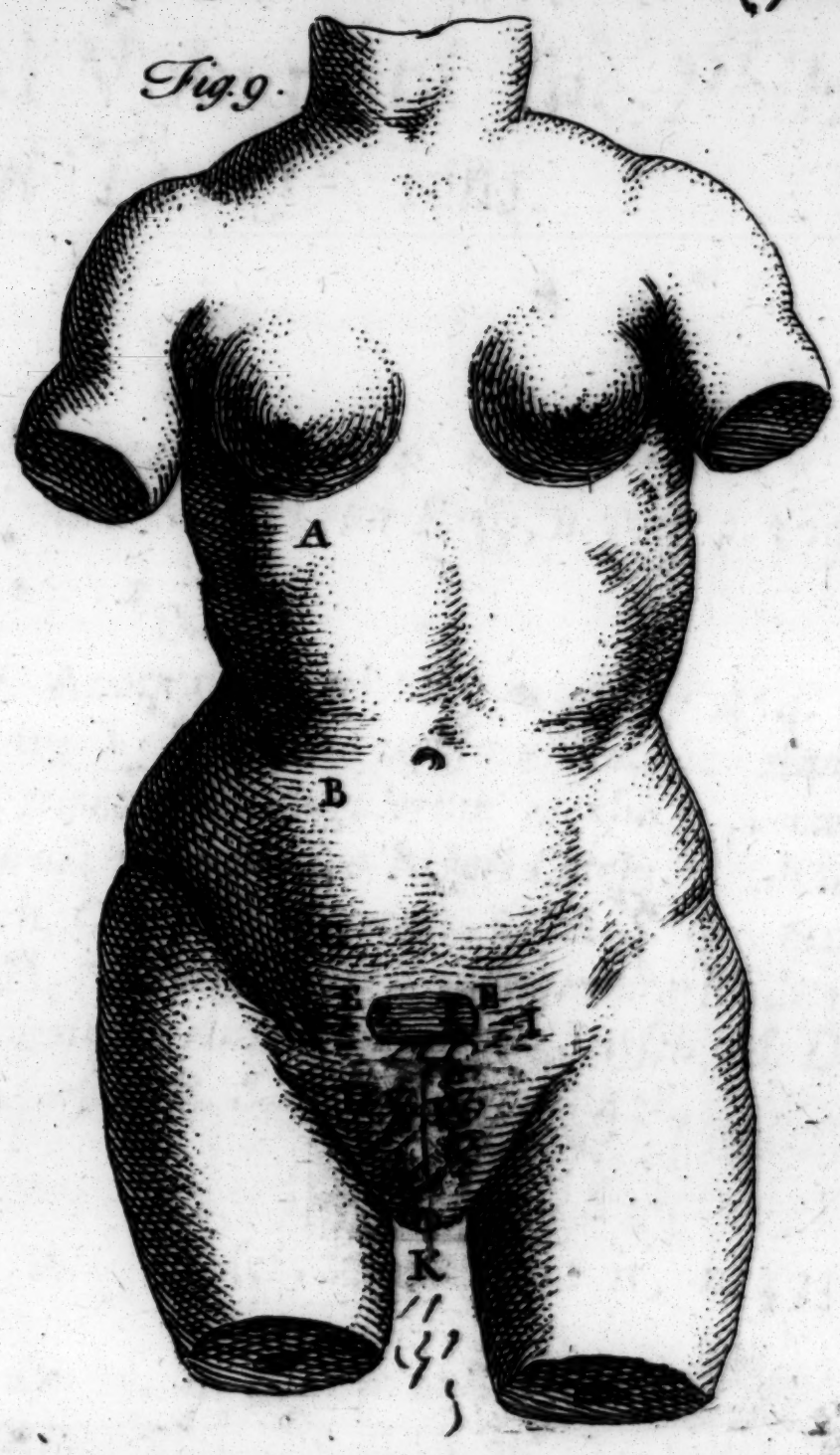
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plate. 3.

Fig. 9.





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